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TESLA'S EXPERIMENTS.

SINCE the publication of the experiments of Hertz and Lodge, one subject has been prominently brought before the electrical world, and has engaged the serious attention of many men; that is, the question of the production of light without the enormous waste of energy which all methods hitherto used have entailed.

Among those who have been devoting much time and trouble to this subject is Mr. Nikola Tesla, and the full text of his researches is now published, and certainly form the finest contribution to practical electricity that has appeared for some time. In it he points the way to what would seem to be a highly probable solution of the problem under consideration, and has even gone a good way in the actual utilisation of the solution he indicates.

Some electrical engineers have for a considerable time been looking in the direction of greatly increased frequency as a means of much improving our present state of alternate current distribution systems, and in February of the present year, during the discussion on Mr. Swinburne's paper on "Transformer Distribution," at the Institution of Electrical Engineers, Mr. Evershed pointed out that the use of high frequency would enable us to greatly reduce the bulk, and possibly increase the efficiency, of present transformers. It is by the employment of immensely high frequencies, and the almost necessarily following high potentials, that Mr. Tesla has been able to arrive at his wonderful results.

This high frequency he got in two ways. Machines giving as many as 20,000 to 30,000 alternations per second were constructed and used as the source of current, but if higher frequencies were required, a second circuit was taken from a Leyden jar; this was charged from a coil, and the time constant of the second circuit so arranged as to give an oscillating current on discharge; by this means far higher frequencies were obtainable. In this case we have the condenser acting like a frequency-transformer as well as a potential-transformer. Having thus provided his source of current, Mr. Tesla proceeded with the experiments. They are of so interesting and extensive a character, that it is impossible to do more than refer to a few of the more striking. Lamps with a single block of refractory substance were rendered luminous with only one lead to them; and further than this, by exciting a high potential alternating field, it was found possible to light up tubes in a room with *no* leads at all. These effects were found to be all due to electrostatic waves, and not at all to the electro-magnetic ones. A third very beautiful experiment was to excite a stationary vibration in a very thick copper lead, and to light up lamps by joining them across two ventral segments, thus giving a lamp burning brightly though short circuited. The ordinary brush discharge becomes under the conditions of these experiments an actual flame, resembling in all points save the absence of combustion, an ordinary gas flame.

In all the experiments the insulators as well as conductors got considerably heated. It is very probable that this is due to "hysteresis of K."

The practical issues touched on and suggested by Mr. Tesla are also of great importance to both instrument makers and engineers. He shows that the probable cause of the too frequent break-down of high pressure induction coils is due to the molecular impacts of the air layer intervening between primary and secondary, and consequently all such coils should (if possible) be constructed with a continuous insulation; for this purpose oil would seem a very useful body, and the oil induction coil will probably supersede the ordinary one for all purposes other than medical purposes or for very elementary work. He also points the way to the practical use of condensers in engineering. At present the condenser required to pass any considerable amount of energy would in general be rather bulky, but by the use of very high frequencies the size required may be greatly reduced both for transforming and transmitting energy. He also makes the highly ingenious suggestion of allowing the iron core of a transformer to heat itself up by means of Foucault currents and hysteresis losses to the temperature of maximum permeability. Allowing for the increased space required to surround the iron by fire-proof materials, this would itself greatly diminish the section of iron necessary to carry the flow of

lines, as the permeability could be increased about sixteen times in this manner, and consequently a considerable reduction in size of all transformers would be effected.

It is impossible to read Mr. Tesla's epoch making paper without admiration at the clearness of view and ingenuity of mind exhibited throughout. It would seem that we are at last fairly progressing towards a means of transforming energy into any form we wish without such a disastrous loss of availability as is now inevitable, and a large measure of the credit must be given to Mr. Tesla for helping so much forward this great end.

THE VALUES OF γ AND J.—CARELESS READING.

EPISTOLARY fulminations on the values of γ and J have for months past been frequent in the correspondence columns of the *Engineer*, signed William Donaldson. We have read only those which appeared on the dates July 3rd and July 17th. In them Mr. Donaldson, a Cambridge well-known engineer and wrangler we are told, attacks the work done by Sir William Thomson in the domain of heat, work which is considered, by every man who understands it, to be monumental in its perfection. We have looked into this matter, and although we have found no justification for the statements of Mr. Donaldson, we think that some account of the blunders he has made may be useful to our readers as a warning against careless reading, to which alone we ascribe the whole of Mr. Donaldson's error.

In the *Engineer* for July 3rd, Mr. Donaldson writes :—

THE VALUES of γ AND J.

SIR,—In the course of my investigations on this subject, I have recently read those parts of the article on "Heat" in the "Encyclopædia Britannica," written by Sir William Thomson, which have reference to the value of J, particularly the part which relates specially to the thermodynamic equation giving the absolute temperature of melting ice in terms of J and K, the specific heat of hydrogen at constant pressure, viz. :—

$$t_o = \frac{100}{E}\left(1 - \cdot039 \cdot \frac{v_o}{v_o} \cdot \frac{J\,K}{\pi\, v_o}\right) \qquad (32)$$

in which t_o is the absolute temperature of melting ice, v_o the volume of unit of mass at temperature t_o and pressure π, v_o its volume at temperature t_o and any other pressure p, and K the specific heat of hydrogen. On this equation Sir William Thomson makes the following remarks :—"Regnault finds—'Experiences,' vol. ii., p. 122—that the value of $\frac{K}{\pi\, v_o}$ for hydrogen agrees within $\frac{1}{2}$ per cent. with its value for common air, and for common air he finds K = ·238." Thus, with 423·5—the equivalent in kilogrammetres of 772 foot pounds—for the value of J in metres, we find J K = 100·79 m., and Regnault's observations on the density of the air give for $\pi\, v_o$ — or the height of the homogeneous atmosphere at 0 deg. C.—7,990 m. Hence, for common air, and therefore also for hydrogen, $\frac{J\,K}{\pi\, v_o}$ = ·0126, and thus (32) becomes

$$t_o = \frac{100}{E}\left(1 + c\,\frac{v_o}{v_o}\right) \qquad (33)$$

with c = − ·00049 for hydrogen. For this gas expanding under constant pressure of one atmosphere Regnault found—"Experiences," vol. i., p. 80—E = ·36613, which gives $\frac{100}{E}$ = 273·13 deg., hence (33) with $v_o = v_o$ gives

$$t_o = 273{\cdot}00 \text{ deg.} \qquad (34)$$

This result appears to be a strong corroboration of the correctness of Joule's value of J. On testing, however, I find that very large differences in the value of J make very little differences in the value of t_o. Thus, the value of t_o corresponding to the value 854 foot-pounds of J differs from the value corresponding to 772 foot-pounds by only a few places of decimals of the second order. Equation (32) is therefore of no use for determining the value of J.

Mr. Donaldson is quite in error as to his having read those parts of the article on "Heat" named by him. If he has looked at them sufficiently long to persuade himself that he has read them, then the sooner he closes the books and gets away for a six months' holiday the better for him, for his recent reading must be only a waste of time.

Equation (32) is not one having "reference to the value of J," in the sense of determining that value. The words, "This result appears to be a strong corroboration of the correctness of Joule's value of J" are Mr. Donaldson's only, there is no equivalent statement in the whole article, and no one who understandingly reads it can ever suppose that such corroboration was intended. Any schoolboy who can read the equation would see that since $\frac{100}{E}$ = 273·13 the total of the term containing J as a factor amounts to only the ·13, and therefore if J were made = 0 the value of t_o would be only ·13 higher than 273°. The critic does not see this, and is therefore at the trouble to test the equation arithmetically, substituting 854 for J instead of 772, and finding the difference to be "only a few places of decimals of the second order;" he thereupon pitches into Sir William Thomson although the only one to be blamed is his own impetuous self, saying, as if claiming a victory, "Equation (32) is therefore of no use for determining the value of J." But, whoever said that it was for this use? He, himself, is probably the only man who was ever in need of that information.

The equation (32) is the ordinary equation for the determination of the temperature of melting ice with the addition of the minute correction due to the variation of specific heat, which has been demonstrated by experiments on free expansion. He next gives Maxwell's formula for t_o neglecting this correction, and says "this method of calculation applies to all gases." This, again, is only Mr. Donaldson's statement. Maxwell says, page 214, "Theory of Heat," referring to this correction, "In the case of most of the gases examined by Joule and Thomson there was a slight cooling effect on the gas passing through the plug. In other words, τ was negative, and the absolute temperature was therefore higher than that indicated by the gaseous thermometer." Now, according to Maxwell's own calculation quoted by Mr. Donaldson, t_o = 272·85 by the air thermometer, and he says afterwards, as now quoted, that the cooling effect on the gas passing through the porous plug shows that the absolute temperature must be somewhat higher than that indication. And because Sir Wm. Thomson, working in the same line of thought, has made out that it is ·15 higher, Mr. Donaldson writes to the *Engineer* that "if Maxwell's method of computing the temperature of melting ice is right and exact, which it undoubtedly is, Sir William Thomson's must be wrong. Both cannot be right." Surely it is clear that Maxwell says that Thomson is right. And even the small difference between the two was referred to by Maxwell as a required correction, so that both are quite right.

He then says :—"Without, however, going into the details of the investigation, it may easily be shown that equation

(32) is, for *primâ facie* reasons, wrong. Equations of relations between different quantities can exist only (1) when all the quantities are constant, (2) when at least two are mutually interdependent variables. Equation (32) *contains only one* independent variable, v_o, and is, therefore, an impossible equation."

These criteria are the only true statements in these letters, but the self-appointed critic cannot use the weapons he has himself produced. Through not reading the article, he has not yet realised that both E and v_o are variables and interdependent. If E were the same between 0° and 100°, whatever pressure we start from at 0°, the gaseous thermometer would give the true temperatures, and there would be no need for the second term in the equation. He works out as he believes, the *ratio ad absurdum*, by calculating t_o, starting with $v_o = \infty$, and he gets it to be = 273·13°. But the formula tells us also that when $v_o = \infty$ the value of E is ·36630 instead of ·36613, and $t_o = 273°$ as before. He next makes $v_o = \frac{1}{2000}$th part of the volume under atmospheric pressure, and gets $t_o =$ approaching zero. But here again he does not perceive that in that experiment E has also just that value which gives $t_o = 273°$.

In his next letter, July 17th, he says, "I challenge —— to point out a single instance in which the error alleged by me to exist does not exist." Another —— has here pointed out the errors, as requested, and the list is not yet complete. He goes on to say :—

> What weight, then, are we to attach to this confirmation? If in this investigation Sir William Thomson can be shown to have committed grave errors, clearly none.
>
> Equation (32) is contained in section 56, p. 572, vol. ii., "Encyclopædia Britannica." This section deals entirely with the relation between work and heat, and therefore all changes in the pressures, volumes, and temperatures, must be adiabatic changes.
>
> It is stated to have been proved by the experiments made by Joule and Sir William Thomson that "δt is simply proportional to δp, not merely for an infinitesimal differences of pressure, but for pressures up to five or six atmospheres." Now, in adiabatic changes t varies as $p^{\frac{\gamma-1}{\gamma}}$, and therefore δt does not vary as δp. In one case only does δt vary simply as δp, viz., when the volume remains constant, and the changes are produced by the addition or subtraction of heat; but then this law was proved to hold true for all pressures and temperatures, and all increments of pressure and temperature, by Boyle and Marriotte long before the time of Joule and Sir William Thomson.
>
> From the results of these experiments it is stated to have been proved that
>
> $$\frac{\delta t}{\delta p} = -\frac{\cdot 039}{\pi}.$$
>
> In the course of my investigations, I have met with some amazing statements, but none so amazing as the statement that $\pi \frac{\delta t}{\delta p}$ is equal to a constant negative abstract number. A rise in temperature caused by the application of heat may be accompanied by a fall in pressure, if the volume is simultaneously increased, and in this case δt and δp having different signs, the product $\pi \frac{\delta t}{\delta p}$ would be negative, but not constant. It can only be constant when the volume remains constant, but in this case δt and δp have the same sign. When, therefore, the changes are not brought about adiabatically, the product $\pi \frac{\delta t}{\delta p}$ may have a positive, but not a negative, constant value.

The reader will please remember that Mr. Donaldson claims to have recently read the article he is criticising. He does not rightly interpret even the signification of the symbols employed, and he imagines that the δt and δp are the simultaneous increments of temperature and pressure in constrained adiabatic changes. He is amazed at the negative sign. If he had conscientiously perused the article he would have known that δt stands for a *reduction* of temperature—it stands for *cooling*, not *heating*. This is rather awkward for a man who declares he has recently read the article, but this pitfall is a very good test for finding out what amount of serious attention the critic has given to the work which he so freely condemns. Perhaps Mr. Donaldson will be still more amazed when we tell him that, so far from t varying as $p^{\frac{\gamma-1}{\gamma}}$, as he says it ought to have done, in some of the experiments discussed in the article criticised the variation of t, for three atmospheres of range of pressure, actually did not exceed the one-tenth part of 1° Centigrade. The δt and δp are the observations obtained in the porous plug experiments on free expansion, but Mr. Donaldson believed he had quite a different cat in the bag. Without discovering his mistake he gives an algebraic demonstration to prove that $\pi \frac{d t}{d p}$ is always positive. But that collar belongs to the other cat. The one in the article read delta t and delta p as quoted by him throughout the portion of his letter which we have reproduced here. In the article there is also a $d t$ and $d p$, but we are afraid Mr. Donaldson has been paying no attention to these differences.

As we have not read his previous letters we will not follow him in his further remarks about the values that have been assigned to γ and J. We would urge upon Mr. Donaldson the necessity of reading more carefully what he presumes to criticise, and again we advise him to take a holiday.

Were it not that Sir William Thomson is looked upon as the *doyen* of the electrical world we should have probably passed this matter by unnoticed; now we trust that he, also, may enjoy a well-earned rest without being haunted by visions of γ and J.

The Perpetual Motion.

In a discourse given by Mr. P. Blatchford, judge of the supreme court of the United States of America, on the occasion of the centenary celebration of the American patents law, the instance was cited of Edward III. granting a patent to two of his subjects who claimed the privilege of manufacturing the philosopher's stone. Other instances of the same kind could doubtless be found by the diligent historian, who would search the records of ancient times, but it is rather amusing to observe that the official examiners of patents at Berlin have in more recent times granted patents to no less than two inventors who claim to have found the perpetual motion. These patents have not yet expired. One is dated April 19th, 1878, and was granted to Dr. Gebhard Ackermann, of Sagan, for a pendulum "carrying permanent magnets and oscillating in the neighbourhood of magnetic centres. The second of these patents stands in the name of Mons. Hosmer Godhue, of Rome, and is dated April 5th, 1879. His object is much the same but the means are rather more complicated. The *Elektrotechnische Zeitschrift* of Berlin, in a recent issue pokes some rather heavy fun at these would-be benefactors of the world of labour, and without giving further details as to dates, &c., cites an invention recently patented in Bavaria in which the object is to produce a force by turning a magnet under the action of a current, in such a way that if the patentee were only acquainted with the rudiments of electricity he would know to be impossible. In fact the inventor thinks that possible, which Ampère long ago demonstrated to be impossible, the resultant of elementary actions of this

kind being not a couple but a simple impulsion. It is well to recall the fact that these scientific judges who have granted patent rights to the inventions are bound by law to pronounce on the *practicability* of the inventions which are submitted to them as well as stating that they are novel. This makes the joke all the richer, and we should certainly recommend these foreign patent offices to so amend their rules that the entire responsibility should rest with the patentee as regards any declaration of practicability, in this way they may prevent themselves becoming ridiculous.

The Scientific Irish Bull.

AN instructive and interesting controversy is now going on in the pages of the *Engineer* on "Force and Motion," in which Prof. FitzGerald, of Belfast, is taking an active, not to say highly amusing, part. His last letter contains something to be grateful for in the shape of a true Irish bull of the finest breed and most massive proportions. "There must be an obstacle exerting the second force on A. If there is no obstacle, the force it exerts cannot exist." We have here a beautiful illustration of the confusion of ideas existing in his mind. How a force which does not exist can be exerted is indeed a *crux*, but then his nationality is responsible for these brilliant little examples of the *Bos Mullingaricus* of the Emerald Isle. Prof. FitzGerald will, we are sure, appreciate the following touching little story which is an incident, not of scientific, but of lowly life :—

"Och, Jamie, did ye never hear me great spache afore O'i left Ireland ?"

"No, Pat ; how should I ? for sure I was not on the ground."

"Well, Jamie, you see O'i was called upon by me friends for a spache afore O'i would go, an', be jabers, O'i rose amid the enthusiastic cheers of thousands, wid me heart overflowing wid gratitude, an' me eyes filled wid tears, an' divil a word could O'i spake !"

Prof. Crookes on Electric Lighting.

WHEN, a few weeks ago, Prof. Wm. Crookes, F.R.S., formally inaugurated the first central station of the Notting Hill Electric Light Company, he certainly put forward every possible effort to impress upon the minds of the somewhat fashionable assembly of residents of the district the advantages of the low tension system of incandescent lighting. His address on that occasion was, in fact, interesting throughout. It was not of the cut and dried order, but was popular and like up-to-date sermons, it was short and sweet. It was perhaps good policy, which will doubtless be adopted elsewhere, to invite the inhabitants of the locality to be present, as a better advertisement than a practical demonstration of electrical illumination could not be obtained. Prof. Crookes, like Mr. W. H. Preece, has had his residence lighted electrically for several years, and he interested the assembly by relating two or three incidents. Ten years ago, when he installed the generating plant in his house, some of the neighbours, hearing that a dynamo was being put down, became greatly alarmed, imagining that "dynamo" was inseparable from "dynamite," an explosive then regarded with considerable public apprehension. The professor made a hit in reciting that incident, but he scored higher on calling into the room a "member" of the engineering staff who had been exceedingly useful in the laying of the mains. This "member" turned out to be a small dog which had been trained to run through the culverts with a rope in his mouth, and by that means the mains had been drawn through. After pointing out the danger, and deprecating the use of high tension current, the speaker said he would show the assembly the harmlessness of the low pressure system adopted by the company, namely, 100 volts in the houses, the distribution being on the three-wire system. He then placed his hands on two copper bars through which the current was at that moment passing out of the station, and invited any lady or gentleman to test the non-dangerous system of supply. No one, however, seemed disposed to try the experiment, and he then proceeded to show that no fire could result in a house through the accidental breakage of an incandescent lamp. After placing a handkerchief over a lighted glow lamp, the latter was broken, and the former remained intact. Light for light, said the speaker, electricity was not as cheap as gas. When, however, the incidental savings effected, that is through the non-blackening of the ceilings, non-soiling of the wall papers, the keeping comparatively clean of the curtains and drapery, the non-polution of the atmosphere with productions of combustion, &c., were taken into consideration, the cost of the incandescent electric light was in his opinion less than that of gas illumination. Thus Prof. Crookes and Mr. Preece almost entirely agree on this point, the former going slightly further in his statement than the latter. We know of one instance, and one only, where the cost of incandescent lighting was found at the end of two years to be about the same as that of gas. This was in a butcher's establishment where 100 glow lamps were used, and where it was, as is usual in that trade, the policy to make a great display of light. Similar cases, if any, are worth recording.

The Electric Light and the growth of Plants.

WE have noted a growing disposition on the part of scientific horticulturists and agriculturists to see what can be done with electricity in the cultivation of vegetable life. Up to the present, perhaps in spite of the researches of French and Russian scientists, as well as of English workers, little of a practical nature has yet been accomplished, although it has certainly been demonstrated that electricity can be made of indirect utility in cultivation. In connection with this (as it may be aptly termed) field of research, we notice a successful experiment by Mr. Rawton, of Arlington, Massachusetts, U.S.A. He has really been investigating the action of the electric rays upon plant life and has succeeded in proving that it would be of considerable advantage to gardeners in forcing plants under glass for the early markets. Mr. Rawton has confined his experiments to the growth of lettuces in a greenhouse about 70 yards long by eight yards wide. Every day the greenhouse was illuminated by means of an arc lamp, and through the night as well. The results obtained were very encouraging and showed an improved rate of growth equal to 20 per cent. At this rate the gardener who uses the electric light gains one week in every five on his competitors who trust to unassisted nature. This fact is certainly worthy of consideration. There is a market for everything that is "out of season," and the gardener who first exploits this market can command almost any price, and according to Mr. Rawton will make profits which will recoup the installation and maintenance of the electric light. Mr. Rawton ought to know what he is about, and he has been so encouraged by the financial success of his experiments that he is laying out greenhouses fitted with the electric light on the large scale. It is worth noting the alleged fact that whilst the electric light hastens the growth of plants it does not encourage insect pests.

ELECTROLYTIC RESEARCHES.

OUR readers may remember some experiments made by Herr Grotthus some time ago in which he passed a current of electricity through two aqueous solutions of nitrate of silver which were so arranged that they could communicate by means of a fine crack in the test tube which contained one of these nitrate solutions. The positive electrode of the battery was immersed in the vessel which contained the other solution. Grotthus noticed that after the current had been passing under these conditions metallic silver was deposited on the outside of the crack in the test tube whilst oxygen gas was given off from the inner side. An account of their experiments may be read in No. 61 at page 65 of *Gilbert's Annalen der Physik und Chemie*.

Herr F. Braun has been attracted to repeating these experiments of Grotthus and has confirmed the original observation. He finds, however, that certain conditions are essential. The silver is only deposited when the intensity of the current of electricity has attained a certain minimum value, which value depends itself upon the strength of the solution of nitrate of silver that is under examination.

Herr Braun pushed these researches further, and examined into the behaviour of solutions of certain other metallic salts under similar conditions, these were the following, namely,

(1) Salts of nickel
(2) „ manganese.
(3) „ lead.
(4) „ gold.
(5) Salts of palladium.
(6) „ cobalt.
(7) „ iron.

Of these metallic salts, those appearing as (3), (4), (5), (6) and (7) in the above list exhibited the same phenomenon as was observed with the silver salt, but the salts of nickel and manganese appeared to be exceptions to the rule, for no metallic depositions were noticed. The formation of a metallic peroxide which might conduct as a metal seems to be without influence in producing the electrolysis.

The phenomenon is very interesting to observe. As the current passes through the solution bubbles of gas may be seen in process of formation inside the crack in the test tube, which pulsate as they increase in size and are liberated on reaching the surface. This was also observed in the case of acids and alkaline salts.

More interesting still is the phenomenon when the electrolysis is observed in the dark. Tiny sparks flash across the crack and light up momentarily its contents.

Should any of our readers be disposed to repeat these experiments, they will notice that the breadth of the crack need not be very narrow. Braun was able to observe the electrolysis with cracks in a plate of mica that were at least 0·06 millimetre wide. He attributes the sparks to the recombination of the oxygen and hydrogen gases contained in the bubbles within the crack which are liberated by the current passing through the aqueous solution. This phenomenon promises to be still further interesting, and Braun is at present engaged in extending his investigation. A full account of the above may be read in the *Annalen der Physik und Chemie*, series [2], No. xlii., p. 450.

FURTHER NOTES ON THE CHEMISTRY OF STORAGE BATTERIES.

IN our issue for August 23rd, 1890, we gave some account of Frankland's researches on the chemistry of storage batteries. He contended that the lead compounds which play the chief part in the chemical re-actions which take place on charging and discharging secondary cells are really sub-sulphates of lead.

Messrs. Gladstone and Hibbert, however, demonstrated a short time ago that one at least of these so-called sub-sulphates is not a definite chemical compound. We noted this in the ELECTRICAL REVIEW of January 2nd, 1891. Neither of Frankland's sub-sulphates could be formed on treating litharge with dilute sulphuric acid, and Messrs. Gladstone and Hibbert came to the conclusion that the ordinary sulphate of lead is the substance which is produced in the voltaic re-action.

They have more recently proved, apparently quite satisfactorily, that the substance, $Pb_3\ S_2\ O_{10}$, derived from the sulphuric acid and the red lead may be decomposed by an aqueous solution of acetate of ammonia, which dissolves out lead sulphate and leaves lead peroxide behind. This shows that Frankland's $Pb_3\ S_2\ O_{10}$ must have been a mixture.

It will be remembered that Frankland treated red lead, $Pb_3\ O_4$, with successive portions of dilute sulphuric acid, until the liquid exhibited a permanent re-action; this was found to yield a brownish-red compound corresponding to the formula $Pb_3\ S_2\ O_{10}$. This salt together with the buff-coloured powder resulting from a similar treatment of lead oxide, Frankland believed to constitute the original active material of storage cells. In the case of the red salt, if this be the active material, then the following equation was held to represent the action at different plates on charging and discharging :—

A. On charging :—

i. Positive plates—

$$2\ Pb_3\ S_2\ O_{10} + 2\ O_2 + 4\ H_2O = 6\ PbO + 4\ H_2\ SO_4.$$

ii. Negative plates—

$$Pb_3\ S_2\ O_{10} + 4\ H_2\ O = 3\ Pb + 2\ H_2\ SO_4 + 2\ H_2\ O.$$

B. On discharging :—

i. Positive plates—

$$6\ PbO_2 + 4\ H_2\ SO_4 + 4\ H_2 = 2\ Pb_3\ S_2\ O_{10} + 8\ H_2\ O.$$

ii. Negative plates—

$$3\ Pb + 2\ H_2\ SO_4 + 2\ O_2 = Pb_3\ S_2\ O_{10} + 2\ H_2\ O.$$

But now this view must be modified unless Frankland succeeds in overthrowing this attack. If Messrs. Gladstone and Hibbert are able to maintain their ground, then the chemistry of the storage battery seems likely to be capable of much simpler explanation than has been anticipated by some.

It is worth noticing that an analysis of the residue left by the action of pure dilute sulphuric acid on spongy lead during a period of five months gave the following composition :—

Lead sulphate	...	...	82 parts.
Metallic lead	...	...	18 „
Total	...	...	100

Only 11 per cent. of metallic lead remained in the residue when sodium sulphate was mixed with the acid and spongy lead exposed to their combined action for the same period.

ELECTRICAL NOTES FROM DEMERARA.

THE Town Council of Georgetown, Demerara, have decided to light the city by electricity on and from January 1st, 1892. It may be remembered that they took advantage last year of a clause in their last agreement with the Gas Company to make an experimental trial with 50 lamps, or rather to allow the recently incorporated Electric Light and Power Company, Limited, to do so for them. Five arcs of 1,200 C.P. and 25 25-C.P. incandescents were put up, and have been running ever since, with very general satisfaction, whilst the two clubs, two newspaper offices, the chief hotels and rum shops, together with the General Post Office and some private houses, have taken up some 450 lights. The gas service has been so poor, that a large number of private houses went back to oil. As it is impossible to have the gas in the airy galleries where people love to rest, the enclosed incandescent lights are most favourably received. At the ball given in honour of Her Majesty's birthday, at Government House, an arc lamp illuminated the grounds, and the *al fresco* gallery decorated with cool palm leaves and lit up with large incandescent lamps, was a favourite resort, both on account of its light and coolness. It may look a high figure to English eyes to talk of gas at 14s. 7d. (or three dollars and a half), per thousand; but that is the sum paid in Georgetown. The electric light is supplied at about 25 per cent. below, although the price of coal ranges from

30s. to 40s. per ton. A special ordinance—or local Act of Parliament—with regulations, has been passed, giving the company an area of 1½ miles by half a mile, and limiting the cost per unit to 30 cents, or 1s. 3d. The Thomson-Houston system is used, with transformers, the larger places paying for the light by meter, at 25 cents per unit. There is thus a fair prospect before the company which is purely the outcome of local energy. Mr. S. Vyle, the government electrician, upon whose calculations the company was started, has recently had his position changed from that of consulting electrician to director, the Lieut.-Governor having sanctioned his acting in that capacity.

The last "Combined Court," or money voting assembly, created a new appointment of assistant electrician for British Guiana; and it is hoped that the gentleman selected will shortly arrive to take up his duties. The work of entirely renewing the telegraph is well in hand, Mr. Vyle having four gangs on the big job; and when the insulators and copper wire—for iron wire is to be dispensed with—is erected, a vast improvement may be looked for, both in the insulation and conductivity of the lines, the resistance of which now averages 50 ohms per mile, chiefly owing to the large number of dry joints. Added to this the telephones in the City of Georgetown are to be increased by 200, with a 50-wire exchange opened at New Amsterdam, some 70 miles distant. The Telephone Exchange in Georgetown continues to work most satisfactory, and the complete equipment of the new one will be welcomed. Then will follow a desire for communication between the two places, and trunk wires will become a necessity with a mile and a half of special cable, *à la* the London-Paris line, now working so well.

ELECTRICITY IN THE MANUFACTURE OF PHOSPHORUS.

ONE of the most interesting of the modern applications of electricity to the manufacture of chemicals is to be found in the recently perfected process known as the Readman-Parker process, after the inventors Dr. J. B. Readman, F.R.S.E., &c., of Edinburgh, and Mr. Thomas Parker, the well-known practical electrician of Wolverhampton.

Before giving an account of this process, which has advanced beyond the experimental to the industrial stage, it may be well to recall the fact that for several years past Dr. Readman has been devoting an enormous expenditure of labour, time and money to the perfection of a process which shall cheapen the production of phosphorus by dispensing altogether with the use of sulphuric acid for decomposing the phosphate of lime which forms the raw material of the phosphorus manufacturer, and also with the employment of fire-clay retorts for distilling the dessicated mixture of phosphoric acid and carbon which usually forms the second stage of the operation.

The success of the recent applications of electricity in the production of certain metals and alloys led Dr. Readman to try this source of energy in the manufacture of phosphorus, and the results of the first series of experiments were so encouraging that he took out provisional protection on October 18th, 1888, for preparing this valuable substance by its means.

The experiments were carried on at this time on a very small scale, the power at disposal being very limited in amount. Yet the elements of success appeared to be so great, and the decomposition of the raw material was so complete, that the process was very soon prosecuted on the large scale.

After a good deal of negotiation with several firms that were in a position to supply the electric energy required, Dr. Readman finally made arrangements with the directors of the Cowles Company, Limited, of Milton near Stoke-on-Trent, the well-known manufacturers of alloys of aluminium, for a lease of a portion of their works and for the use of the entire electrical energy they produced for certain portions of the day.

The experiments on the large scale had not advanced very far before Dr. Readman became aware that another application for letters patent for producing phosphorus had been made by Mr. Thomas Parker, of Wolverhampton, and his chemist, Mr. A. E. Robinson. Their joint patent is dated December 5th, 1888, and was thus applied for only seven weeks after Dr. Readman's application had been lodged.

It appeared that Mr. Parker had conducted a number of experiments simultaneously, but quite independently of those carried on by Dr. Readman, and that he was quite unaware—as the latter was unaware—of any other worker in this field. It was no small surprise, therefore, to find during an interview which took place between these rival inventors some time after the date referred to, that the two patents were on practically the same lines, namely, the production of phosphorus by electricity.

Their interests lay so much together that, after some delay, they arranged to jointly work out the process, and the result has been the formation of a preliminary company and the erection on the large scale of experimental plant in the neighbourhood of Wolverhampton to prove the commercial success of the new system of manufacturing phosphorus.

Before describing these experimental works it may be as well to see with what plant Dr. Readman has been working at the Cowles Company's works. And here we may remark that we are indebted to a paper read by Dr. Readman at the Philosophical Institution, Edinburgh, a short time ago; this paper being the third of a series which during the last year or two have been read by the same scientist on this branch of chemical industry. Here is an abstract giving a description of the plant. The works are near the Milton Station, on the North Staffordshire Railway. The boilers for generating the steam required are of the Babcock-Wilcox type, and are provided with "mechanical stokers"; the steam engine is of 600 H.P., and is a compound condensing horizontal tandem, made by Messrs. Pollitt & Wigzel, of Sowerby Bridge. The fly-wheel of this engine is 20 feet in diameter, and weighs 30 tons, and is geared to the pulley of the dynamo, so that the latter makes five revolutions for each revolution of the engine by rope driving gear, consisting of eighteen ropes. The engine is an extremely fine specimen of a modern steam engine; it works so silently that a visitor standing with his back to the engine railings, at the time the engine is being started, cannot tell whether it is in motion or not.

With regard to the dynamo, the spindle is of steel, 18 feet long, with three bearings, one being placed on either side of the driving pulley. The diameter is 7 inches in the bearings, and 10 inches in the part within the core. This part in the original forgings was 14 inches in diameter, and was planed longitudinally, so as to leave four projecting ribs or radial bars on which the core discs are driven, each disc having four key ways corresponding to these ribs. There are about 900 of these discs, the external diameter being 20 inches, and the total length of the core 36 inches.

The armature winding consists of 128 copper bars, each ⅞ inch deep, measured radially, by ⅜ inch wide. These bars are coupled up so as to form thirty-two conductors only; this arrangement has been adopted to avoid the heating from the Foucault currents, which, with 1½-inch conductors, would have been very considerable. The bars are coupled at the ends of the core across a certain chord and are insulated.

The commutator is 20 inches long, and has sixty-four parts. The current is collected by eight brushes mounted on a separate ring, placed concentric to the commutator; and the current is led away from these brushes by a large number of thin bands of sheet copper strapped together into convenient groups. The field magnets are of the horizontal double type.

As this machine is virtually a series wound machine, the magnet coils each consist of a few turns only of forged copper bars, 1½ inch wide by 1 inch thick, forged to fit the magnet cores.

There is no insulation other than mica wedges to keep the bars from touching the core.

The dynamo furnishes a current of about 5,000 amperes, with an E.M.F. of 50 to 60 volts, and three years ago was claimed to be the largest machine, at least as regards quantity of current, in the world.

The current from the dynamos is led by copper bars to an enormous "cut-out," calculated to fuse at 8,000 amperes. This is probably one of the largest ever designed, and consists of a framework carrying twelve lead plates, each 3½ inch × $\frac{1}{10}$th inch thick. A current indicator is inserted in the circuit consisting of a solenoid of nine turns. The range of this indicator is such that the centre circle of 360° = 8,000 amperes.

The electrodes consisted of a bundle of nine carbons, each 2½ inches in diameter, attached by casting into a head of cast iron. Each carbon weighs 20 lbs., and when new, is about 48 inches long.

The head of the electrode is screwed to the copper rods or "leads," which can be readily connected with the flexible cables supplying the current.

The electric furnaces are rectangular troughs built of fire-brick, their internal dimensions being 60 inches × 20 inches × 36 inches deep. Into each end is built a cast-iron tube, through which the carbon electrodes enter the furnace.

The electrodes are so arranged that it is possible by means of screwing, to advance or withdraw them from the furnace.

The whole current generated by the great dynamo of the Cowles Company was passed through the furnace.

In the experiments raw materials only were used, for it was evident that it was only by the direct production of phosphorus from the native minerals which contain it, such as the phosphates of lime, magnesia or alumina, that there was any hope of superseding, in point of economy, the existing process of manufacture.

In the furnaces as used at Milton much difficulty was experienced in distributing the heat over a sufficiently wide area. So locally intense indeed was the heat within a certain zone, that all the oxygen contained in the mixture was expelled and alloys of iron, aluminium, and calcium combined with more or less silicon, and phosphorus were produced. Some of these were of an extremely interesting nature.

We now turn to a short account of the works and plant which have been erected near Wolverhampton to prove the commercial success of the new system of manufacturing phosphorus.

The ground is situated on the banks of a canal and extends to about 10 acres, which are wholly without buildings except those which have been erected for the purposes of these industrial experiments. These consist of boiler and engine houses, and large furnace sheds.

There are three Babcock and Wilcox steam boilers of 160 H.P. each, and each capable of evaporating 5,000 lbs. of water per hour. The water tubes are 18 feet long × 4 inches diameter, and the steam and water drums 42 inches in diameter and 23½ feet long of steel $\frac{7}{16}$ths inch thick, provided with a double dead-head safety valve, stop valves, blow-off cock, water gauges, and steam gauge.

The total heating surface on each boiler is 1,619 square feet, and the total grate surface is 30 square feet.

The boilers are worked at 160 lbs. pressure.

The engine is a triple compound one of the type supplied for torpedo boats, and built by the Yarrow Ship-building Company. It is fitted with a Pickering governor for constant speed. The engine is capable of delivering (with condenser) 1,200 I.H.P., and without condenser 250 I.H.P. less.

With steam at 170 lbs. pressure the engine worked at 350 revolutions per minute, but it has been re-arranged so as to deliver 700 I.H.P. with 160 lbs. steam pressure without condenser, and at 300 revolutions per minute :—

The high pressure cylinder is 14½ inches diameter.
„ intermediate „ „ 25 „ „
„ low pressure „ „ 32 „ „
„ stroke is 16 inches.

The dynamo for producing the requisite amount of electric current supplied to the furnaces is one of the well-known Elwell-Parker type of alternating current dynamos, designed to give 400 units of electrical energy, equivalent to 536 I.H.P.

The armature in the machine is stationary, with double insulation between the armature coils and the core, and also between the core and the frame, and is so arranged that its two halves may be readily connected in series or in parallel in accordance with the requirements of the furnaces, *e.g.*, at an electromotive force of 80 volts it will give 5,000 ampères, and at 160 volts, 2,500 ampères when running at 300 revolutions per minute.

The exciting current of the alternator is produced by an Elwell-Parker shunt wound machine, driven direct from a pulley on the alternator shaft, and so arranged as to give 90 ampères at 250 volts when running at a speed of 800 revolutions per minute. From 60 to 70 ampères are utilised in the alternator, the remainder being available for lighting purposes (which is done through accumulators) and general experimental purposes.

The process is carried out in the following way :—The raw materials, all intimately and carefully mixed together, are introduced into the furnace and the current is then turned on. Shortly afterwards, indications of phosphorus make their appearance.

The vapours and gases from the furnace pass away to large copper condensers—the first of which contains hot and the second cold water—and finally pass away into the air.

As the phosphorus forms, it distils off from the mixture, and the residue forms a liquid slag at the bottom of the furnace. Fresh phosphorus-yielding material is then introduced at the top. In this way the operation is a continuous one, and may be continued for days without intermission.

The charges for the furnace are made up with raw material, *i.e.*, native phosphates without any previous chemical treatment, and the only manufactured material necessary—if such it may be called—is the carbon to effect the reduction of the ores.

The crude phosphates obtained in the condensers is tolerably pure, and is readily refined in the usual way.

Dr. Readman and Mr. Parker have found that it is more advantageous to use a series of furnaces instead of sending the entire current through one furnace. These furnaces will each yield about 1½ cwt. of phosphorus per day.

Analyses of the slag show that the decomposition of the raw phosphates is very perfect, for the percentage of phosphorus left in the slag seldom exceeds 1 per cent.

HUTIN AND LEBLANC'S ALTERNATING CURRENT MOTOR.

[COMMUNICATED.]

THE alternating current motor of Messrs. Hutin and Leblanc, which has recently been presented to the French scientific societies by M. Leblanc, belongs to the class of motors with a revolving magnetic field.

It consists in principle of a system of fixed inductors constituting the magnetic field and a movable armature closed upon itself moving inside the revolving field produced by the fixed inductors.

The special characteristic of M. Leblanc's motor lies in the mode in which the revolving field is produced. In his first experiments, M. Ferraris produced this field by realising for the first time currents with multiple phases, and using two distinct circuits traversed by alternating currents interlagging one another for a quarter of each period, and supplied by one armature. This method required four wires, or at least three, if one common return wire were used.

The motors, with revolving fields, invented by M. Haselvander and M. Dolivo-Dobrowolsky, concerning which so much has been said during the last few months, are also motors with revolving fields produced by currents with multiple phases, the most simple method being to use three currents interrupting one another during a third of each period, in such a manner that the algebraical sum of each of these three currents may be always nil. Under these conditions, each wire serves as a return wire for the sum of the two currents which pass through the two other wires at the same instant.

But in the present state of distribution by alternating currents, there are no systems of currents with multiple phases in use, and a special installation of production is required in order to supply motors of this kind.

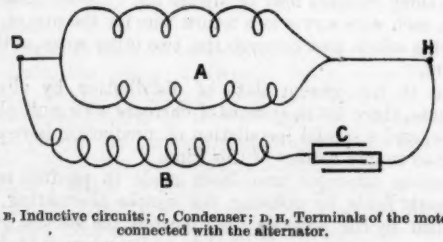
Various attempts have been made to produce revolving magnetic fields by utilising the simple alternating current supplied by the ordinary distributions, the electric generator being connected with the electric motor which it feeds by two wires only forming a simple circuit traversed by a periodic current.

The problem consists in subdividing this single current into two others, which have between them a lag of about a quarter of a period, and thus they play the part of a periodic alternating current with multiple phases. Many solutions have been suggested. M. Tesla proposed to feed one of the circuits directly, the second being supplied by a

transformer. He also proposed the employment of two derivations, one having a high, and the other a low, coefficient of self-induction, the lag thus produced in the currents passing through the two circuits being sufficient to realise the revolving field.

But the most convenient and the most practical method of obtaining the result sought, is, without doubt, the employment of the condensers as proposed and realised for the first time with a view to their application to alternating current motors, by M. Maurice Leblanc.

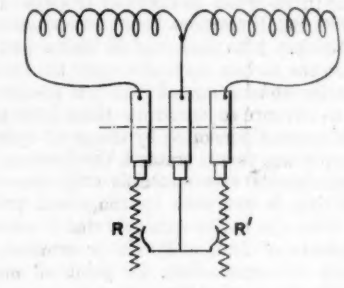
We know, in fact, that by introducing a condenser into a circuit presenting self-induction, the apparent coefficient of self-induction of the whole is diminished, as well as the lag of the current passing through the self-induction coil and the condenser, with regard to the electromotive force producing this current. It is this property which is applied in M. Leblanc's motor. The inductive system of this motor is formed of a ring bearing 16 projections of laminated iron radiating from the inner part of a fixed drum and forming a cylindrical hollow in which is placed the armature. On the polar projections are placed 16 bobbins; they are numbered successively 1, 2, 3, ... 14, 15, 16. These 16 bobbins form two distinct groups; those bearing uneven numbers form the circuit, A, and those bearing even numbers the circuit, B. The 8 bobbins of circuit A are connected together, four in series, and form two circuits connected directly in derivation on the wire coming from the generator. The 8 bobbins forming circuit B are connected in series and also arranged in derivation on the generator, by introducing a condenser of suitable capacity. Under these conditions, the derivations formed by the two circuits, A and B, are traversed by periodic currents having between them a lag of a quarter of a period, thus satisfying the conditions necessary to the production of a revolving magnetic field, although the generator furnishes a single current only. Fig. 1 shows the coupling of these 16 inductive coils. Of course, in the machine with a revolving field produced by 16 bobbins, the complete rotation of the field is really effected only at the rate of $\frac{1}{4}$th of a revolution in a period, a complete revolution occupying 4 periods. M. Leblanc's machine is therefore a 16 pole machine.



A, B, Inductive circuits; C, Condenser; D, H, Terminals of the motor connected with the alternator.

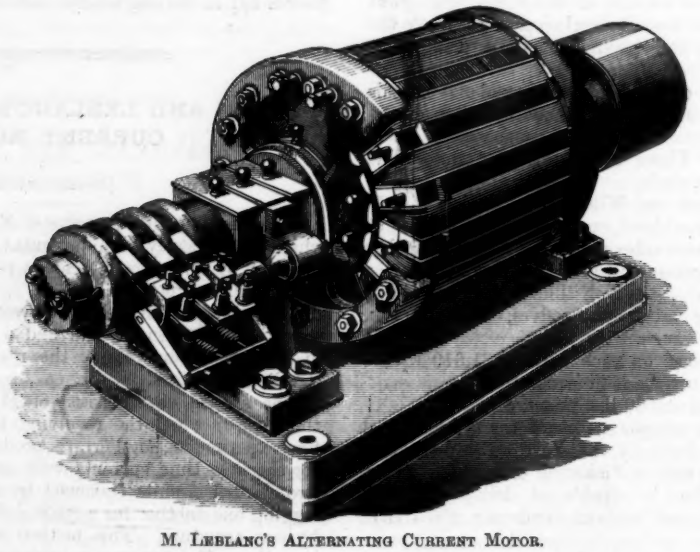
FIG. 1.—COUPLING OF THE INDUCTORS OF MESSRS. HUTIN AND LEBLANC'S ALTERNATING CURRENT MOTOR.

The movable circuit consists of two polygonal windings, crossing one another, and each containing 8 bobbins. The spirals of these bobbins are fastened into 16 slots cut in a cylindrical drum formed of sheets of iron cut out and laid one upon another. The 16 induced coils form two distinct circuits (fig. 2), each containing 8 bobbins connected in series. Their extremities are connected with three collecting rings, one ring being common to two circuits; three brushes rub on these rings, these brushes being connected with two rheostats, R, R′, worked by hand, which enable a variable resistance to be introduced into each circuit. At starting, this resistance should be made considerable, so as to increase the motive torque. When the speed is increased, the resistances introduced into each of the induced circuits is gradually diminished, until the moment when the resistance in the rheostat becomes nil, the armatures being short-circuited. The motor then turns at its normal maximum speed.



R, R′, Rheostats.

FIG. 2.—COUPLING OF THE ARMATURES.



M. LEBLANC'S ALTERNATING CURRENT MOTOR.

The machine had been calculated to produce 15,000 watts with a frequency of 120 periods per second, but the generator used did not allow of a frequency of more than 83 periods per second, or of an available power of more than 8,000 watts, the corresponding electrical efficiency being 89 per cent. The corresponding industrial efficiency could not be determined for want of a wattmeter, or some other instrument that would allow of the power supplied being measured with some exactness.

ELEMENTARY THEORY OF MOTORS WITH A REVOLVING MAGNETIC FIELD AND CLOSED ARMATURE.

This theory was brought forward for the first time by M. Ferraris in his note presented in March, 1888, to the Academy of Turin, but the conclusions in his theory were

not strictly accurate, as it did not take into account the self-induction of the induced circuit. Messrs. Hutin and Leblanc have established a much more complete theory; and we will now sum up its principal points, partly from their note and partly from an excellent article by M. Frank Géraldy on the theory of machines with a revolving magnetic field, published in *La Lumière Electrique*, July 4th, 1891.

Inductive Current.—The inductive current supplied by the generator branches out into two parts, one of which, A, contains eight inducing bobbins connected in two derivations of four bobbins in series, the other, B, contains the eight other inducing bobbins connected in series, this second circuit being cut out by a condenser. By adopting the proper proportions between the capacity of the condenser and the frequency we can arrange that the intensities passing through the two circuits respectively should be lagging for a quarter of a period, and satisfy the equations

$$I_A = A \sin \omega_1 t,$$
$$I_B = A \cos \omega_1 t,$$

taking it for granted, once for all, that

$$\omega_1 = \frac{2\pi}{T_1},$$

$\frac{1}{T_1}$ being the frequency of the alternating currents, or the number of complete periods ($\sim$) per second, passing through the primary or inductive circuit.

Under these conditions the resulting magnetic field is a revolving one. We will suppose, in order to simplify the reasoning and the explanation, that there is one single revolving field, and that this revolving field makes one complete revolution in each period. In the multipolar motor constructed by M. Leblanc, there are really four revolving fields and one complete revolution of the field corresponds to four periods.

The inductive revolving field thus makes N_1 revolutions per second, assuming that $N_1 = \frac{1}{T_1}$.

Armatures.—The induced bobbins, 16 in number, may also be considered, for the sake of argument, as one single bobbin subjected to the action of the revolving field. This armature being at first motionless, it will be the seat of alternating currents of a frequency of $\frac{1}{T_1}$, or N_1 periods per second.

If, on the other hand, we supposed the magnetic field to be fixed in space, and that we cause the induced bobbin to turn with an angular speed of N_2 turns per second, it would be the seat of alternating currents of a frequency of $\frac{1}{T_2} = N_2$.

As the armature moves under the action of the inductive field, induced currents are developed in it which oppose the creation of the currents which would exist in this armature if it were kept motionless with regard to the revolving field. These induced currents are only manifested therefore in virtue of the relative angular speed $N = N_1 - N_2$ of the inductors and the armature. These currents are at their maximum when $N_2 = 0$, *i.e.*, when the armature is motionless; they have a tendency to diminish when N_2 is increased and would become nil in a motor theoretically perfect, when we should get $N_2 = N_1$ and $N = 0$.

If we disregard the reactions of the armature, which are very slight in a well proportioned machine, we can establish the equations of the alternating current motor thus constituted, taking the frequency of the alternating current generated in the armature to be equal to $N_1 - N_2 = N = \frac{1}{T}$, and assuming that $\frac{2\pi}{T} = \omega$.

We will call Φ_t the total flow of magnetic induction produced by the inductor on the armature during a relative period, T. (This value, Φ_t, is four times that of the real flow, as it is easier to establish it, taking the variations during the whole period.) The value of the mean electromotive force induced, E_2, will therefore be

$$E_2 = \frac{\Phi}{T}$$

and if the induced circuit has a resistance, R_2, and a coefficient of self-induction, L_2, we shall get for the value of the effective intensity, I_2,

$$I_2 = \frac{\phi}{T\sqrt{R_2^2 + \omega^2 L_2^2}} = \frac{N\phi}{\sqrt{R_2^2 + \omega^2 L_2^2}}$$

with a lag, ϕ, of such a value that

$$\tan \phi = \frac{\omega L_2}{R_2},$$

and the intensity at each moment, i_2, will be, if we call $I_{0\cdot 2}$ the maximum intensity

$$i_2 = I_{0\cdot 2} \cos (\omega t - \phi)$$

We will call H_1 the intensity of the revolving magnetic field produced by the inductors, an intensity which is constant in principle and definition. The motive couple, W_t, exercised at each moment by the field on the induced circuit will evidently have for its value at the moment, t,

$$W_t = H_1 i_2 \cos \omega t = H_1 I_{0\cdot 2} \cos \omega t \cos (\omega t - \phi)$$

In M. Leblanc's motor the two systems of induced bobbins may be considered as two bobbins interrupting one another for a quarter of a period, so that, *mutatis mutandis*, we may write down the value of the motive couple for this second circuit as

$$W^1_t = H_1 i_2 \sin \omega t = H_1 I_{0\cdot 2} \sin \omega t \sin (\omega t - \phi)$$

and for the total couple on the two bobbins,

$$W_t + W_t^1 = H_1 I_{0\cdot 2} [\cos \omega t \cos (\omega t - \phi) + \sin \omega t \sin (\omega t - \phi)]$$

and

$$W_t = H_1 I_{0\cdot 2} \cos \phi$$

but the factor, $\cos \phi$, becomes nil as well as the motive torque. This motive couple is at its maximum when $\tan \phi = 1$, corresponding to a lag of $\frac{1}{8}$th of a period, which takes place when

$$R_2 = \omega L_2$$

The resistance of the induced circuit which gives the maximum torque is therefore a linear function of the relative angular speed, ω.

When the motor is stopped, at start R_2 must be made great, and diminished as the angular speed increases, so as to satisfy the condition

$$R_2 = \omega L_2$$

We then get, if this condition is satisfied,

$$\cos \phi = \frac{1}{\sqrt{2}}$$

We should get at starting a motive torque which would be weaker than during the normal working if we did not make R_2 vary. To enable us to vary R_2 in each of the induced circuits, these circuits are connected, as we have seen, with collectors and brushes, between which are introduced rheostats, which also enable the angular speed to be regulated or varied.

Electrical Efficiency.—If we disregard the power lost in the inductors, and this loss can be made as little as desired by employing a wire of sufficient thickness, we can easily deduce from the preceding formulæ the value of the electrical efficiency, η, which is as follows:—

$$\eta = \frac{N_1}{N_2}$$

It depends, therefore, only on the ratios of the angular speeds, and it becomes equal to 1 when $N_1 = N_2$, but then the power produced is nil, as no current passes into the induced circuit.

Practically we obtain high efficiency as the angular speeds, N_1 and N_2 of the revolving field and of the armatures differ by a few hundredths only. It follows, therefore, that the resistance

$$R_2 = \omega L_2$$

must be very small. The formula relating to the power produced, shows on the other hand that the angular speed, N_2, must be very great in order that the motor may have great specific power. The alternating current motors, with revolving field and closed armature, must therefore work at a very high frequency, and the fact of their existence is one more justification for the researches undertaken with the object of producing currents of high frequency for industrial purposes.

M. Leblanc's researches have brought out the fact that condensers can be utilised practically and industrially for suppressing the detrimental effects of self-induction, and show how these condensers must be constructed in order that they may effectually resist the high tensions to which they are subjected. This use of condensers will besides be more advantageous and economical in proportion as currents of greater frequency are used. Without seeking, like Professor Elihu Thomson and M. Tesla, to attain to frequencies of 5,000 and even 10,000 periods per second, it seems that we might go much further than we do, and exceed the figures of 133, which are at present the highest, and are only employed by Westinghouse.

A system of alternating currents in which condensers and self-induction coils are combined, has, at each instant, much less potential energy than an ordinary circuit; hence it follows that accidental breakages of the circuit are much less dangerous as regards the preservation of the apparatus and physiological effects, so that we can thus attain much higher tensions.

If we add, finally, that alternating currents are less detrimental to the preservation of the insulators than continuous currents, and less in proportion as their frequency is greater, that alternating current motors not requiring a commutator cannot cause any sparks, since the circuits are never cut, except at the time of starting or stopping, it will easily be understood that these properties fully justify the restoration to favour with which alternating currents are being received by electricians of both worlds.

These researches undertaken with the object of increasing the advantages and the applications of alternating currents cannot fail to advance electrical science, and still further aid its progress, already so rapid.

THE ATKINSON-ELLIOTT MAGNETIC SEPARATOR.

AMONGST the machines shown at the recent meeting of the Royal Agricultural Society at Doncaster, and entered as a new implement, was the magnetic separator, illustrated. This machine is intended to remove bolts, nuts, nails, horse-shoes, &c., from bones, oil cake, or minerals before they are passed into disintegrating machines, as the presence of these foreign bodies is very detrimental to the machines. The chief difficulties that had to be overcome in designing this machine were the large size and irregular shapes of the material to be treated, the fact, also, that the iron, particularly in bones, is frequently entangled in the bones, so that merely passing the substance *once* over or on to a magnet was not found sufficient to ensure the absolutely certain removal of the foreign substance. These points have been satisfactorily overcome by the use of a hollow truncated cone with ten internal magnets of alternately opposite polarity. The cone revolves on outside runners driven by friction only, which is found ample for the purpose.

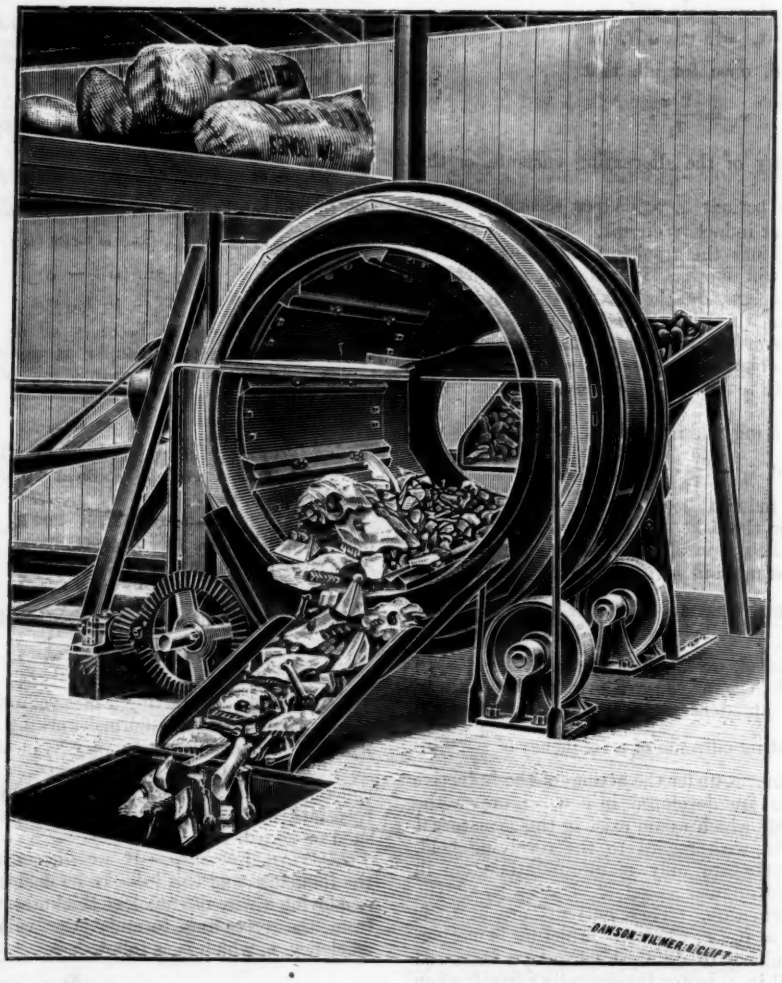
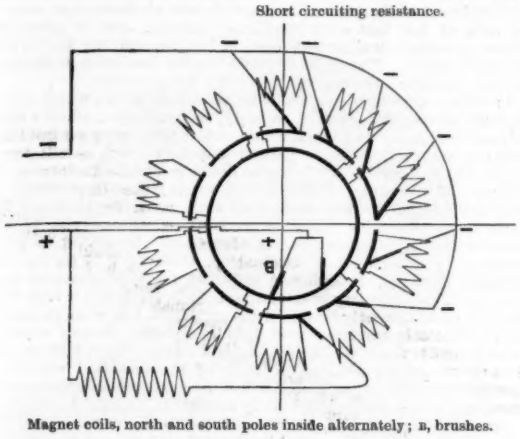


FIG. 1.

Into the back end the bones are fed by a shoot, and, falling to the bottom, are rolled over and over again, so that as they gradually travel forward—in about 10 or 15 complete revolutions—to the front they pass 100 to 150 times over the magnets. In the upper part, or the barrel, is a fixed tray, into which the iron is carried and collected. Each magnet in turn, as it comes to the bottom, is magnetised, and remains so till it reaches the top where it becomes demagnetised and the iron is detatched.

This process is carried out by a commutating ring on the back of the machine, and the arrangement (shown in diagram 2) is such that each coil has one end permanently con-

nected to one pole of the dynamo, and the other ends are in turn connected during one half a revolution to the other pole. Thus the magnets receive current in parallel. Before cutting a coil out of circuit it is short-circuited through a resistance, and by this means no sparking of any consequence occurs.



Magnet coils, north and south poles inside alternately; B, brushes.

FIG. 2.

The machine has proved itself a very practical success, and the value of the repeated revolutions over the magnets has been demonstrated by repeated trials. The power required to excite the magnets is about 600 watts for the largest size capable of dealing with 4 tons of bones per hour.

The machine was exhibited by the Hardy Patent Pick Company, of Sheffield, makers of the "Devil" disintegrator, and was manufactured by W. T. Goolden & Co., under the joint patents of Messrs. Ll. and C. Atkinson and G. W. Elliott.

EXPERIMENTS WITH ALTERNATE CURRENTS OF VERY HIGH FREQUENCY AND THEIR APPLICATION TO METHODS OF ARTIFICIAL ILLUMINATION.*

BY NIKOLA TESLA.

THERE is no subject more captivating, more worthy of study, than nature. To understand this great mechanism, to discover the forces which are active, and the laws which govern them, is the highest aim of the intellect of man.

Nature has stored up in the universe infinite energy. The eternal recipient and transmitter of this infinite energy is the ether. The recognition of the existence of ether, and of the functions it performs, is one of the most important results of modern scientific research. The mere abandoning of the idea of action at a distance, the assumption of a medium pervading all space and connecting all gross matter, has freed the minds of thinkers of an ever-present doubt, and, by opening a new horizon—new and unforeseen possibilities—has given fresh interest to phenomena with which we are familiar of old. It has been a great step towards the understanding of the forces of nature and their multifold manifestations to our senses. It has been for the enlightened student of physics what the understanding of the mechanism of the firearm or of the steam engine was for the barbarian. Phenomena upon which we used to look as wonders baffling explanation, we now see in a different light. The spark of an induction coil, the glow of an incandescent lamp, the manifestations of the mechanical forces of currents and magnets are no longer beyond our grasp; instead of the incomprehensible, as before, their observation suggests now in our minds a simple mechanism, and although as to its precise nature all is still conjecture, yet we know that the truth cannot be much longer hidden, and instinctively we feel that the understanding is dawning upon us. We still admire these beautiful phenomena, these strange forces, but we are helpless no longer; we can in a certain measure explain them, account for them, and we are hopeful of finally succeeding in unravelling the mystery which surrounds them.

In how far we can understand the world around us is the ultimate thought of every student of nature. The coarseness of our senses prevents us from recognising the ulterior construction of matter, and astronomy, this grandest and most positive of natural sciences, can only teach us something that happens, as it were, in our immediate neighbourhood: of the remoter portions of the boundless universe, with its numberless stars and suns, we know nothing. But far beyond the limit of perception of our senses the spirit still can guide us, and so we may hope, that even these unknown worlds—infinitely small and great—may in a measure become known to us. Still, even if this knowledge should reach us, the searching mind will find a barrier, perhaps for ever unsurpassable, to the *true* recognition of that which *seems* to be, the mere *appearance* of which is the only and slender basis of all our philosophy.

Of all the forms of nature's immeasurable, all-pervading energy, which ever and ever changing and moving, like a soul animates the inert universe, those of electricity and magnetism are perhaps the most fascinating. The effects of gravitation, of heat and light we observe daily, and soon we get accustomed to them, and soon they lose for us the character of the marvellous and wonderful; but electricity and magnetism, with their singular relationship, with their seemingly dual character, unique among the forces in nature, with their phenomena of attractions, repulsions and rotations, strange manifestations of mysterious agents, stimulate and excite the mind to thought and research. What is electricity, and what is magnetism? These questions have been asked again and again. The most able intellects have ceaselessly wrestled with the problem; still the question has not as yet been fully answered. But while we cannot even to-day state what these singular forces are, yet we have made good headway towards the solution of the problem. We are now confident that electric and magnetic phenomena are attributable to ether, and we are perhaps justified in saying that the effects of static electricity are effects of ether under strain, and those of dynamic electricity and electro-magnetism effects of ether in motion. But this still leaves the question, as to what electricity and magnetism are, unanswered.

First, we naturally inquire, What is electricity, and is there such a thing as electricity? In interpreting electric phenomena, we may speak of electricity or of an electric condition, state, or effect. If we speak of electric effects, we must distinguish two such effects, opposite in character and neutralising each other, as observation shows that two such opposite effects exist. This is unavoidable, for in a medium of the properties of ether we cannot possibly exert a strain or produce a displacement or motion of any kind, without causing in the surrounding medium an equivalent and opposite effect. But if we speak of electricity, meaning a *thing*, we must, I think, abandon the idea of two electricities, as the existence of two such things is highly improbable. For how can we imagine that there should be two things, equivalent in amount, alike in their properties, but of opposite character, both clinging to matter, both attracting and completely neutralising each other? Such an assumption, though suggested by many phenomena, though most convenient for explaining them, has little to commend it. If there *is* such a thing as electricity, there can be only *one* such thing, and excess and want of that one thing, possibly; but more probably its condition determines the positive and negative character. The old theory of Franklin, though falling short in some respects, is, from a certain point of view, after all, the most plausible one. Still, in spite of this, the theory of the two electricities is generally accepted, as it apparently explains electric phenomena in a more satisfactory manner. But a theory which better explains the facts is not necessarily true. Ingenious minds will invent theories to suit observation, and almost every independent thinker has his own views on the subject.

It is not with the object of advancing an opinion, but with the desire of acquainting you better with some of the results, which I will describe, to show you the reasoning I have followed, the departures I have made—that I venture to express in a few words the views and convictions which have led me to these results.

I adhere to the idea that there is a thing which we have been in the habit of calling electricity. The question is, What is that thing? or What, of all things, the existence of which we know, have we the best reason to call electricity? We know that it acts like an incompressible fluid; that there must be a constant quantity of it in nature; that it can be neither produced nor destroyed; and, what is more important, the electro-magnetic theory of light and all facts observed teach us that electric and ether phenomena are identical. The idea at once suggests itself, therefore, that electricity might be called ether. In fact, this view has in a certain sense been advanced by Dr. Lodge. His interesting work has been read by everyone, and many have been convinced by his arguments. His great ability and the interesting nature of the subject keep the reader spellbound; but when the impressions fade, one realises that he has to deal only with ingenious explanations. I must confess that I cannot believe in two electricities, much less in a doubly-constituted ether. The puzzling behaviour of the ether as a solid to waves of light and heat, and as a fluid to the motion of bodies through it, is certainly explained in the most natural and satisfactory manner by assuming it to be in motion, as Sir William Thomson has suggested; but regardless of this, there is nothing which would enable us to conclude with certainty that, while a fluid is not capable of transmitting transverse vibrations of a few hundred or thousand per second, it might not be capable of transmitting such vibrations when they range into hundreds of million millions per second. Nor can anyone prove that there are transverse ether waves emitted from an alternate current machine, giving a small number of alternations per second; to such slow disturbances, the ether, if at rest, may behave as a true fluid.

Returning to the subject, and bearing in mind that the existence of two electricities is, to say the least, highly improbable, we must remember that we have no evidence of electricity, nor can we hope to get it, unless gross matter is present. Electricity, therefore, cannot be called ether in the broad sense of the term; but nothing would seem to stand in the way of calling electricity ether associated with matter, or bound ether; or, in other words, that the so-called static

* A lecture delivered before the American Institute of Electrical Engineers, at Columbia College, N.Y., May 20th, 1891.

charge of the molecule is ether associated in some way with the molecule. Looking at it in that light, we would be justified in saying that electricity is concerned in all molecular actions.

Now, precisely what the ether surrounding the molecules is, wherein it differs from ether in general, can only be conjectured. It cannot differ in density, ether being incompressible; it must, therefore, be under some strain or in motion, and the latter is most probable. To understand its functions, it would be necessary to have an exact idea of the physical construction of matter, of which, of course, we can only form a mental picture.

But of all the views on nature, the one which assumes one matter and one force, and a perfect uniformity throughout, is the most scientific and most likely to be true. An infinitesimal world, with the molecules and their atoms spinning and moving in orbits, in much the same manner as celestial bodies, carrying with them, and probably spinning with them, ether, or, in other words, carrying with them static charges, seems to my mind the most probable view, and one which, in a plausible manner, accounts for most of the phenomena observed. The spinning of the molecules and their ether sets up ether tensions or electrostatic strains; the equalisation of ether tensions sets up ether motions or electric currents, and the orbital movements produced the effects of electro and permanent magnetism.

About 15 years ago, Prof. Rowland demonstrated a most interesting and important fact, namely, that a static charge carried around produces the effects of an electric current. Leaving out of consideration the precise nature of the mechanism, which produces the attraction and repulsion of currents, and conceiving the electrostatically charged molecules in motion, this experimental fact gives us a fair idea of magnetism. We can conceive lines or tubes of force which physically exist being formed of rows of directed moving molecules; we can see that these lines must be closed: that they must tend to shorten and expand, &c. It likewise explains in a reasonable way the most puzzling phenomenon of all, permanent magnetism, and, in general, has all the beauties of the Ampère theory without possessing the vital defect of the same, namely, the assumption of molecular currents. Without enlarging further upon the subject, I would say that I look upon all electrostatic current and magnetic phenomena as being due to electrostatic molecular forces.

The preceding remarks I have deemed necessary to a full understanding of the subject as it presents itself to my mind.

Of all these phenomena the most important to study are the current phenomena, on account of the already extensive and ever-growing use of currents for industrial purposes. It is now a century since the first practical source of current has been produced, and, ever since, the phenomena which accompany the flow of currents have been diligently studied, and through the untiring efforts of scientific men, the simple laws which govern them have been discovered. But these laws were found to hold good only when the currents are of a steady character. When the currents are rapidly varying in strength, quite different phenomena, often unexpected, present themselves, and quite different laws hold good, which even now have not been determined as fully as is desirable, though through the work, principally of English scientists, enough knowledge has been gained on the subject to enable us to treat simple cases which now present themselves in daily practice.

The phenomena which are peculiar to the changing character of the currents are greatly exalted when the rate of change is increased, hence the study of these currents is considerably facilitated by the employment of properly constructed apparatus. It was with this and other objects in view that I constructed alternate current machines capable of giving more than two million reversals of current per minute, and to this circumstance it is principally due that I am able to bring to your attention some of the results thus far reached, which I hope will prove to be a step in advance on account of their direct bearing upon one of the most important problems, namely, the production of a practical and efficient source of light.

The study of such rapidly alternating currents is very interesting. Nearly every experiment discloses something new. Many results may, of course, be predicted, but many more are unforeseen. The experimenter makes many interesting observations. For instance, we take a piece of iron and hold it against a magnet. Starting from low alternations, and running up higher and higher, we feel the impulses succeed each other faster and faster, get weaker and weaker, and finally disappear. We then observe a continuous pull; the pull, of course, is not continuous; it only appears so to us; our sense of touch is imperfect.

We may next establish an arc between the electrodes and observe as the alternations rise, that the note which accompanies alternating arcs gets shriller and shriller, gradually weakens, and finally ceases. The air vibrations, of course, continue, but they are too weak to be perceived; our sense of hearing fails us.

We observe the small physiological effects, the rapid heating of the iron cores and conductors, curious inductive effects, interesting condenser phenomena, and still more interesting light phenomena with a high tension induction coil. All these experiments and observations would be of the greatest interest to the student, but their description would lead me too far from the principal subject. Partly for this reason, and partly on account of the vastly greater importance, I will confine myself to the description of the light effects produced by these currents.

In the experiments to this end a high tension induction coil or equivalent apparatus for converting currents of comparatively low into currents of high tension is used.

If you will be sufficiently interested in the results I shall describe as to enter into an experimental study of this subject; if you will be convinced of the truth of the arguments I shall advance, your aim will be to produce high frequencies and high potentials; in other words, powerful electrostatic effects. You will then encounter many difficulties, which, if completely overcome, would allow us to produce truly wonderful results.

First will be met the difficulty of obtaining the required frequencies by means of mechanical apparatus, and, if they be obtained otherwise, obstacles of a different nature will present themselves. Next it will be found difficult to provide the requisite insulation without considerably increasing the size of the apparatus, for the potentials required are high, and, owing to the rapidity of the alternations, the insulation presents peculiar difficulties. So, for instance, when a gas is present, the discharge may work, by the molecular bombardment of the gas and consequent heating, through as much as an inch of the best solid insulating material, such as glass, hard rubber, porcelain, sealing wax, &c.; in fact, through any known insulating substance. The chief requisite in the insulation of the apparatus is, therefore, the exclusion of any gaseous matter.

In general my experience tends to show that bodies which possess the highest specific inductive capacity, such as glass, afford a rather inferior insulation to others, which, while they are good insulators, have a much smaller specific inductive capacity, such as oils, for instance, the dielectric losses being no doubt greater in the former. The difficulty of insulating, of course, only exists when the potentials are excessively high, for with potentials such as a few thousand volts there is no particular difficulty encountered in conveying currents from a machine giving, say 20,000 alternations per second, to quite a distance. This number of alternations, however, is by far too small for many purposes, though quite sufficient for some practical applications. This difficulty of insulating is fortunately not a vital drawback; it affects mostly the size of the apparatus, for, when excessively high potentials would be used, the light-giving devices would be located not far from the apparatus, and often they would be quite close to it. As the air bombardment of the insulated wire is dependent on condenser action, the loss may be reduced to a trifle by using excessively thin wires heavily insulated.

Another difficulty will be encountered in the capacity and self-induction necessarily possessed by the coil. If the coil be large, that is, if it contain a great length of wire, it will be generally unsuited for excessively high frequencies; if it be small, it may be well adapted for such frequencies, but the potential might then not be as high as desired. A good insulator, and preferably one possessing a small specific inductive capacity, would afford a two-fold advantage. First, it would enable us to construct a very small coil capable of withstanding enormous differences of potential; and secondly, such a small coil, by reason of its smaller capacity and self-induction, would be capable of a quicker and more vigorous vibration. The problem, then, of constructing a coil or induction apparatus of any kind possessing the requisite qualities I regard as one of no small importance, and it has occupied me for a considerable time.

The investigator who desires to repeat the experiments which I will describe, with an alternate current machine, capable of supplying currents of the desired frequency, and an induction coil, will do well to take the primary coil out and mount the secondary in such a manner as to be able to look through the tube upon which the secondary is wound. He will then be able to observe the streams which pass from the primary to the insulating tube, and from their intensity he will know how far he can strain the coil. Without this precaution he is sure to injure the insulation. This arrangement permits, however, an easy exchange of the primaries, which is desirable in these experiments.

The selection of the type of machine best suited for the purpose must be left to the judgment of the experimenter. There are here illustrated three distinct types of machines, which, besides others, I have used in my experiments.

Fig. 1 represents the machine used in my experiments before this Institute. The field magnet consists of a ring of wrought iron with

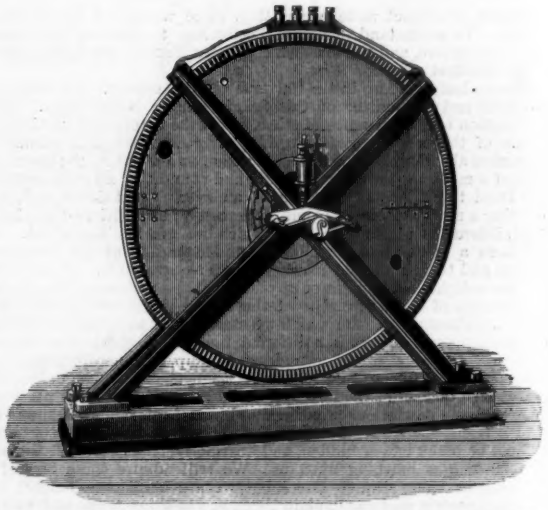


FIG. 1.—HIGH FREQUENCY ALTERNATOR WITH DRUM ARMATURE.

384 pole projections. The armature comprises a steel disc to which is fastened a thin, carefully welded rim of wrought iron. Upon the rim are wound several layers of fine, well-annealed iron wire, which when wound is passed through shellac. The armature wires are wound around brass pins, wrapped with silk thread. The diameter of the armature wire in this type of machine should not be more than

one-sixth of the thickness of the pole projections, else the local action will be considerable.

Fig. 2 represents a larger machine of a different type. The field magnet of this machine consists of two like parts which either enclose an exciting coil, or else are independently wound. Each part has 480 pole projections, the projections of one facing those of the other. The armature consists of a wheel of hard bronze, carrying the conductors which revolve between the projections of the field magnet.

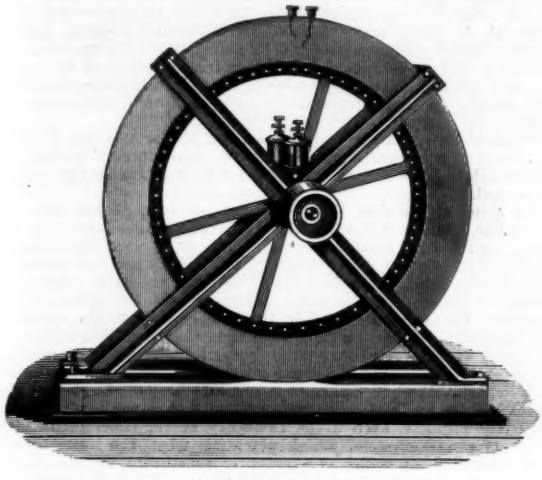


FIG. 2.

HIGH FREQUENCY ALTERNATOR WITH REVOLVING DISC ARMATURE.

To wind the armature conductors, I have found it most convenient to proceed in the following manner: I construct a ring of hard bronze of the required size. This ring and the rim of the wheel are provided with the proper number of pins, and both fastened upon a plate. The armature conductors being wound, the pins are cut off and the ends of the conductors fastened by two rings which screw to the bronze ring and the rim of the wheel respectively. The whole may then be taken off and forms a solid structure. The conductors in such a type of machine should consist of sheet copper, the thickness of which, of course, depends on the thickness of the pole projections; or else twisted thin wires should be employed.

Fig. 3 is a smaller machine, in many respects similar to the former, only here the armature conductors and the exciting coil are kept stationary, while only a block of wrought iron is revolved.

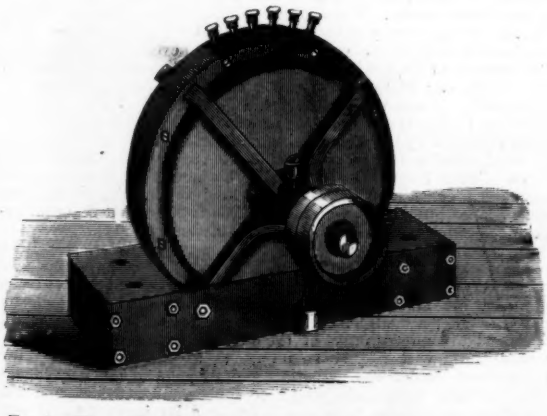


FIG. 3.—HIGH FREQUENCY ALTERNATOR WITH STATIONARY DISC ARMATURE AND STATIONARY EXCITING COIL.

It would be uselessly lengthening this description were I to dwell more on the details of construction of these machines. I deem it well, however, to call the attention of the investigator to two things, the importance of which, though self evident, he is nevertheless apt to underestimate; namely, to the local action in the conductors, which must be carefully avoided, and to the clearance, which must be small. I may add that, since it is desirable to use very high peripheral speeds, the armature should be of very large diameter, in order to avoid impracticable belt speeds. Of the several types of these machines which have been constructed by me, I have found that the type illustrated in fig. 1 caused me the least trouble in construction, as well as in maintenance, and, on the whole, it has been a good experimental machine.

In operating an induction coil with very rapidly alternating currents, among the first luminous phenomena noticed are naturally those presented by the high tension discharge. As the number of alternations per second is increased, or as—the number being high—the current through the primary is varied, the discharge gradually changes in appearance. It would be difficult to describe the minor changes which occur, and the conditions which bring them about, but one may note five distinct forms of the discharge.

First, one may observe a weak, sensitive discharge in the form of a thin, feeble coloured thread (fig. 4). It always occurs when the number of alternations per second being high, the current through the primary is very small. In spite of the excessively small current, the rate of change is great, and the difference of potential at the terminals of the secondary is therefore considerable, so that the arc is established at great distances; but the quantity of "electricity" set in motion is insignificant, barely sufficient to maintain a thin, thread-like arc. It is excessively sensitive, and may be made so to such a degree, that the mere act of breathing near the coil will affect it, and unless it is perfectly well protected from currents of air, it wriggles around constantly. Nevertheless, it is in this form excessively persistent, and when the terminals are approached to, say one-third of the striking distance, it can be blown out only with difficulty. This exceptional persistency, when short, is largely due to the arc being excessively thin, presenting therefore, a very small surface to the blast. Its great sensitiveness, when very long, is probably due to the motion of the particles of dust suspended in the air.

When the current through the primary is increased, the discharge gets broader and stronger, and the effect of the capacity of the coil becomes visible until, finally, under proper conditions, a white flaming arc, fig. 5, often as thick as one's finger, and striking across the whole coil, is produced. It develops remarkable heat, and may be further characterised by the absence of the high note which accompanies the less powerful discharges. To take a shock from the coil under these conditions would not be advisable, although under different conditions the potential being much higher, a shock from the coil may be taken with impunity. To produce this kind of discharge the number of alternations per second must not be too great for the coil used; and, generally speaking, certain relations between capacity, self-induction and frequency must be observed.

The importance of these elements in an alternate current circuit is now well known, and, under ordinary conditions, the general rules are applicable. But in an induction coil exceptional conditions prevail. First, the self-induction is of little importance before the arc is established, when it asserts itself, but perhaps never as prominently as in ordinary alternate current circuits, because capacity is distributed all along the coil, and by reason of the fact that the coil usually discharges through very great resistances; hence the currents are exceptionally small. Secondly, the capacity goes on increasing continually as the potential rises, in consequence of absorption which takes place to a considerable extent. Owing to this there exists no critical relationship between these quantities, and ordinary rules would not seem to be applicable. As the potential is increased either in consequence of the increased frequency, or of the increased current through the primary, the amount of the energy stored becomes greater and greater, and the capacity gains more and more in importance. Up to a certain point the capacity is beneficial, but after that it begins to be an enormous drawback. It follows from this that each coil gives the best result with a given frequency and primary current. A very large coil, when operated with currents of very high efficiency, may not give as much as $\frac{1}{4}$th inch spark. By adding capacity to the terminals, the condition may be improved, but what the coil really wants is a lower frequency.

When the flaming discharge occurs, the conditions are evidently such, that the greatest current is made to flow through the circuit. These conditions may be attained by varying the frequency within wide limits, but the highest frequency at which the flaming arc can still be produced, determines, for a given primary current, the maximum striking distance of the coil. In the flaming discharge the *éclat* effect of the capacity is not perceptible; the rate at which the energy is being stored then just equals the rate at which it can be disposed of through the circuit. This kind of discharge is the severest test for a coil; the break, when it occurs, is of the nature of that in an overcharged Leyden jar. To give a rough approximation, I would state that, with an ordinary coil of, say 10,000 ohms resistance, the most powerful arc would be produced with about 12,000 alternations per second.

When the frequency is increased beyond that rate, the potential, of course, rises, but the striking distance may, nevertheless, diminish, paradoxical as it may seem. As the potential rises the coil attains more and more the properties of a static machine, until, finally, one may observe the beautiful phenomenon of the streaming discharge, fig. 6, which may be produced across the whole length of the coil. At that stage streams begin to issue freely from all points and projections. These streams will also be seen to pass in abundance in the space between the primary and the insulating tube. When the potential is excessively high they will always appear, even if the frequency be low, and even if the primary be surrounded by as much as an inch of wax, hard rubber, glass, or any other insulating substance. This limits greatly the output of the coil, but I will later show how I have been able to overcome to a considerable extent this disadvantage in the ordinary coil.

Besides the potential, the intensity of the streams depends on the frequency; but if the coil be very large they show themselves, no matter how low the frequencies used. For instance, in a very large coil of a resistance of 67,000 ohms, constructed by me some time ago, they appear with as low as 100 alternations per second and less, the insulation of the secondary being $\frac{3}{4}$ inch of ebonite. When very intense they produce a noise similar to that produced by the charging of a Holtz machine, but much more powerful, and they emit a strong smell of ozone. The lower the frequency, the more apt they are to suddenly injure the coil. With excessively high frequencies they

may pass freely without producing any other effect than to heat the insulation slowly and uniformly.

The existence of these streams shows the importance of constructing an expensive coil so as to permit of one's seeing through the tube surrounding the primary, and the latter should be easily exchangeable; or else the space between the primary and secondary should be completely filled up with insulating material so as to exclude all air. The non-observance of this simple rule in the construction of the commercial coils is responsible for the destruction of many an expensive coil.

At the stage when the streaming discharge occurs, or with somewhat higher frequencies, one may, by approaching the terminals considerably and regulating properly the effect of capacity, produce a veritable spray of small silver-white sparks or a bunch of excessively thin silvery threads (fig. 7) amidst a powerful brush—each spark or thread possibly corresponding to one alternation. This, when produced under proper conditions, is probably the most beautiful discharge, and when an air blast is directed against it, it presents a singular appearance. The spray of sparks, when received through the body, causes some inconvenience, whereas, when the discharge simply streams, nothing at all is likely to be felt if large conducting objects are held in the hands to protect them from receiving small burns.

If the frequency is still more increased, then the coil refuses to give any spark unless at comparatively small distances, and the fifth typical form of discharge may be observed (fig. 8). The tendency to stream out and dissipate is then so great that when the brush is produced at one terminal no sparking occurs, even if, as I have repeatedly tried, the hand, or any conducting object, is held within the stream; and, what is more singular, the luminous stream is not at all easily deflected by the approach of a conducting body.

At this stage the streams seemingly pass with the greatest freedom through considerable thicknesses of insulators, and it is particularly interesting to study their behaviour. For this purpose it is convenient to connect to the terminals of the coil two metallic spheres which may be placed at any desired distance (fig. 9). Spheres are preferable to plates, as the discharge can be better observed. By inserting dielectric bodies between the spheres, beautiful discharge phenomena may be observed. If the spheres be quite close and a spark be playing between them, by interposing a thin plate of ebonite between the spheres the spark instantly ceases and the discharge spreads into an intensely luminous circle several inches in diameter, provided the spheres are sufficiently large. The passage of the streams heats, and, after a while, softens the rubber so much that two plates may be made to stick together in this manner. If the spheres are so far apart that no spark occurs, even if they are far beyond the striking distance, by inserting a thick plate of glass the discharge is instantly induced to pass from the spheres to the glass in the form of luminous streams. It appears almost as though these streams pass *through* the dielectric. In reality this is not the case, as the streams are due to the molecules of the air which are violently agitated in the space between the oppositely charged surfaces of the spheres. When no dielectric other than air is present, the bombardment goes on, but is too weak to be visible; by inserting a dielectric the inductive effect is much increased, and besides, the projected air molecules find an obstacle, and the bombardment becomes so intense that the streams become luminous. If by any mechanical means we could effect such a violent agitation of the molecules we could produce the same phenomenon. A jet of air escaping through a small hole under enormous pressure and striking against an insulating substance, such as glass, may be luminous in the dark, and it might be possible to produce phosphorescence of the glass or other insulators in this manner.

The greater the specific inductive capacity of the interposed dielectric, the more powerful the effect produced. Owing to this, the streams show themselves with excessively high potentials even if the glass be as much as 1½ to 2 inches thick. But besides the heating due to bombardment, some heating goes on undoubtedly in the dielectric, being apparently greater in glass than in ebonite. I attribute this to the greater specific inductive capacity of the glass, in consequence of which, with the same potential difference, a greater amount of energy is taken up in it than in rubber. It is like connecting to a battery a copper and a brass wire of the same dimensions. The copper wire, though a more perfect conductor, would heat more by reason of its taking more current. Thus what is otherwise considered a virtue of the glass is here a defect. Glass usually gives way much quicker than ebonite; when it is heated to a certain degree, the discharge suddenly breaks through at one point, assuming then the ordinary form of an arc.

The heating effect produced by molecular bombardment of the dielectric would, of course, diminish as the pressure of the air is increased, and at enormous pressures it would be negligible, unless the frequency would increase correspondingly.

It will be often observed in these experiments that when the spheres are beyond the striking distance, the approach of a glass plate, for instance, may induce the spark to jump between the spheres. This occurs when the capacity of the spheres is somewhat below the critical value which gives the greatest difference of potential at the terminals of the coil. By approaching a dielectric, the specific inductive capacity of the space between the spheres is increased, producing the same effect as if the capacity of the spheres were increased. The potential at the terminals may then rise so high that the air space is cracked. The experiment is best performed with dense glass or mica.

Another interesting observation is that a plate of insulating material, when the discharge is passing through it, is strongly attracted by either of the spheres, that is, by the nearer one, this being obviously due to the smaller mechanical effect of the bombardment on that side, and perhaps also to the greater electrification.

From the behaviour of the dielectrics in these experiments we may conclude, that the best insulator for these rapidly alternating currents would be the one possessing the smallest specific inductive capacity and at the same time one capable of withstanding the greatest differences of potential; and thus two diametrically opposite ways of securing the required insulation are indicated, namely, to use either a perfect vacuum or a gas under great pressure; but the former would be preferable. Unfortunately neither of these two ways is easily carried out in practice.

It is especially interesting to note the behaviour of an excessively high vacuum in these experiments. If a test tube, provided with external electrodes and exhausted to the highest possible degree, be connected to the terminals of the coil, fig. 10, the electrodes of the tube are instantly brought to a high temperature and the glass at each end of the tube is rendered intensely phosphorescent, but the middle appears comparatively dark, and for a while remains cool.

When the frequency is so high that the discharge shown in fig. 8 is observed, considerable dissipation no doubt occurs in the coil. Nevertheless the coil may be worked for a long time, as the heating is gradual.

In spite of the fact that the difference of potential may be enormous, little is felt when the discharge is passed through the body, provided the hands are armed. This is to some extent due to the higher frequency, but principally to the fact that less energy is available externally, when the difference of potential reaches an enormous value, owing to the circumstance that, with the rise of potential, the energy absorbed in the coil increases as the square of the potential. Up to a certain point the energy available externally increases with the rise of potential, then it begins to fall off rapidly. Thus, with the ordinary high tension induction coil, the curious paradox exists, that, while with a given current through the primary the shock might be fatal, with many times that current it might be perfectly harmless, even if the frequency be the same. With high frequencies and excessively high potentials when the terminals are not connected to bodies of some size, practically all the energy supplied to the primary is taken up by the coil. There is no breaking through, no local injury, but all the material, insulating and conducting, is uniformly heated.

To avoid misunderstanding in regard to the physiological effect of alternating currents of very high frequency, I think it necessary to state that, while it is an undeniable fact that they are incomparably less dangerous than currents of low frequencies, yet it should not be thought that they are altogether harmless. What has just been said refers only to currents from an ordinary high tension induction coil, which currents are necessarily very small; if received directly from a machine or from a secondary of low resistance, they produce more or less powerful effects, and may cause serious injury, especially when used in conjunction with condensers.

The streaming discharge of a high tension induction coil differs in many respects from that of a powerful static machine. In colour it has neither the violet of the positive, nor the brightness of the negative, static discharge, but lies somewhere between, being of course, alternatively positive and negative. But since the streaming is more powerful when the point or terminal is electrified positively, than when electrified negatively, it follows that the point of the brush is more like the positive, and the root more like the negative static discharge. In the dark, when the brush is very powerful the root may appear almost white. The wind produced by the escaping streams, though it may be very strong—often indeed to such a degree that it may be felt quite a distance from the coil—is, nevertheless, considering the quantity of the discharge, smaller than that produced by the positive brush of a static machine, and it affects the flame much less powerfully. From the nature of the phenomenon we can conclude that the higher the frequency, the smaller must, of course, be the wind produced by the streams, and with sufficiently high frequencies no wind at all would be produced at the ordinary atmospheric pressures. With frequencies obtainable by means of a machine, the mechanical effect is sufficiently great to revolve, with considerable speed, large pin-wheels, which in the dark present a beautiful appearance owing to the abundance of the streams (fig. 11).

In general, most of the experiments usually performed with a static machine can be performed with an induction coil when operated with very rapidly alternating currents. The effects produced, however, are much more striking, being of incomparably greater power. When a small length of ordinary cotton covered wire, fig. 12, is attached to one terminal of the coil, the streams issuing from all points of the wire may be so intense as to produce a considerable light effect. When the potentials and frequencies are very high, a wire insulated with gutta-percha or rubber and attached to one of the terminals, appears to be covered with a luminous film. A very thin bare wire when attached to a terminal emits powerful streams and vibrates continually to and fro or spins in a circle, producing a singular effect (fig. 13).

Another peculiarity of the rapidly alternating discharge of the induction coil is its radically different behaviour with respect to points and rounded surfaces.

If a thick wire, provided with a ball at one end and with a point at the other, be attached to the positive terminal of a static machine, practically all the charge will be lost through the point, on account of the enormously greater tension, dependent on the radius of curvature. But if such a wire is attached to one of the terminals of the induction coil, it will be observed that with very high frequencies streams issue from the ball almost as copiously as from the point (fig. 14).

It is hardly conceivable that we could produce such a condition to an equal degree in a static machine, for the simple reason, that the tension increases as the square of the density, which in turn is proportional to the radius of curvature; hence, with a steady potential an enormous charge would be required to make streams issue from a

polished ball while it is connected with a point. But with an induction coil the discharge of which alternates with great rapidity, it is different. Here we have to deal with two distinct tendencies. First, there is the tendency to escape which exists in a condition of rest, and which depends on the radius of curvature; second, there is the tendency to dissipate into the surrounding air by condenser action, which depends on the surface. When one of these tendencies is a maximum, the other is at a minimum. At the point the luminous stream is principally due to the air molecules coming bodily in contact with the point; they are attracted and repelled, charged and discharged, and their atomic charges being thus disturbed, vibrate and emit light waves. At the ball, on the contrary, there is no doubt that the effect is to a great extent produced inductively, the air molecules not *necessarily* coming in contact with the ball, though they undoubtedly do so. To convince ourselves of this we only need to exalt the condenser action, for instance, by enveloping the ball, at some distance, by a better conductor, than the surrounding medium, the conductor being, of course, insulated; or else by surrounding it with a better dielectric and approaching an insulated conductor; in both cases the streams will

FIG. 4.—SENSITIVE THREAD DISCHARGE.

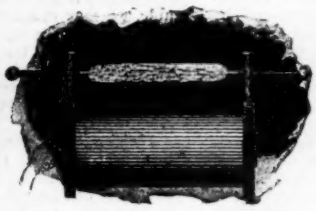


FIG. 5.—FLAMING DISCHARGE.

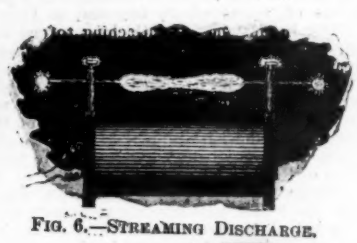


FIG. 6.—STREAMING DISCHARGE.

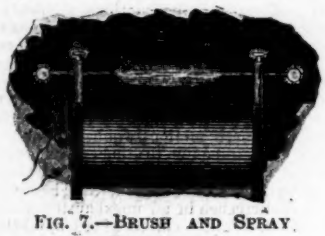


FIG. 7.—BRUSH AND SPRAY DISCHARGE.

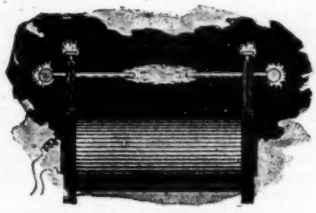


FIG. 8.—FIFTH TYPICAL FORM OF DISCHARGE.

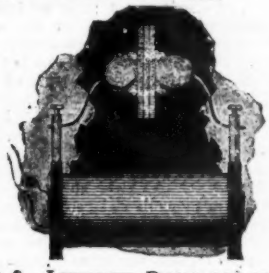


FIG. 9.—LUMINOUS DISCHARGE WITH INTERPOSED INSULATORS.

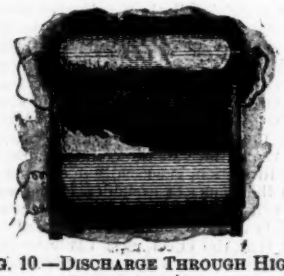


FIG. 10.—DISCHARGE THROUGH HIGHEST VACUUM.

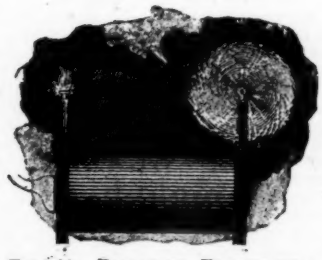


FIG. 11.—PINWHEEL DRIVEN BY A POWERFUL BRUSH.

FIG. 12.—LUMINOUS STREAMS ESCAPING FROM A COTTON-COVERED WIRE.

FIG. 13.—ASPECT PRESENTED BY A VERY THIN WIRE ATTACHED TO A TERMINAL OF THE COIL.

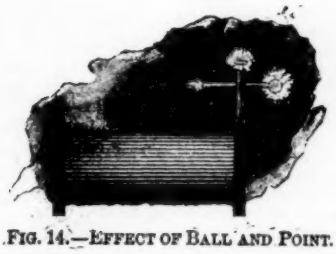


FIG. 14.—EFFECT OF BALL AND POINT.

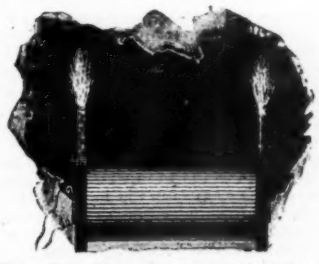


FIG. 15.—ASPECT OF COIL UNDER POWERFUL BRUSH DISCHARGE.

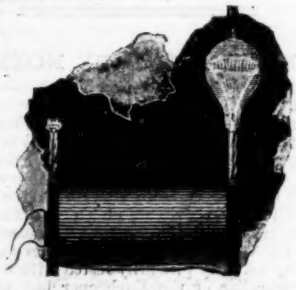


FIG. 16.—INCANDESCENT WIRE OR FILAMENT SPINNING IN AN UNEXHAUSTED GLOBE.

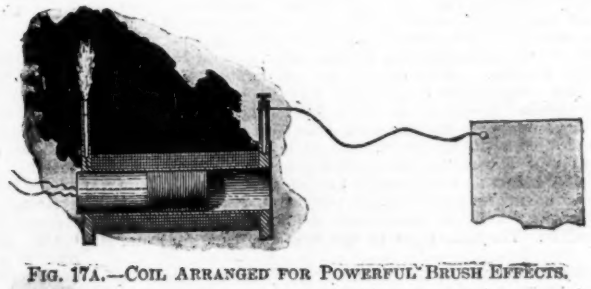


FIG. 17A.—COIL ARRANGED FOR POWERFUL BRUSH EFFECTS.

break forth more copiously. Also, the larger the ball with a given frequency, or the higher the frequency, the more will the ball have the advantage over the point. But since a certain intensity of action is required to render the streams visible, it is obvious that in the experiment described the ball should not be taken too large.

In consequence of this two-fold tendency, it is possible to produce by means of points effects identical to those produced by capacity. Thus, for instance, by attaching to one terminal of the coil a small length of soiled wire, presenting many points and offering great facility to escape, the potential of the coil may be raised to the same value as by attaching to the terminal a polished ball of a surface many times greater than that of the wire.

An interesting experiment, showing the effect of the points, may be performed in the following manner: Attach to one of the terminals of the coil a cotton covered wire about two feet in length, and adjust the conditions so that streams issue from the wire. In this experiment the primary coil should be preferably placed so that it extends only about half way into the secondary coil. Now touch the free terminal of the secondary with a conducting object held in the hand, or else connect it to an insulated body of some size. In this manner the potential on the wire may be enormously raised. The effect of this will be to either increase, or to diminish, the streams. If they increase, the wire is too short; if they diminish, it is too long. By adjusting the length of the wire, a point is found where the touching of the other terminal does not at all affect the streams. In this case the rise of potential is exactly counteracted by the drop through the coil. It will be observed that small lengths of wire produce considerable difference in the magnitude and luminosity of the streams. The primary coil is placed sidewise for two reasons: First, to increase the potential at the wire and, second, to increase the drop through the coil. The sensitiveness is thus augmented.

There is still another and far more striking peculiarity of the brush discharge produced by very rapidly alternating currents. To observe this it is best to replace the usual terminals of the coil by two metal columns insulated with a good thickness of ebonite. It is also well to close all fissures and cracks with wax so that the brushes cannot form anywhere except at the tops of the columns. If the conditions are carefully adjusted—which, of course, must be left to the skill of the experimenter—so that the potential rises to an enormous value, one may produce two powerful brushes several inches long, nearly white at their roots, which in the dark bear a striking resemblance to two flames of a gas escaping under pressure (fig. 15). But they do not only *resemble*, they *are* veritable flames, for they are hot. Certainly they are not as hot as a gas burner, *but they would be so if the frequency and the potential would be sufficiently high.* Produced with, say, twenty thousand alternations per second, the heat is easily perceptible even if the potential is not excessively high. The heat developed is, of course, due to the impact of the air molecules against the terminals and against each other. As, at the ordinary pressures, the mean free path is excessively small, it is possible that in spite of the enormous initial speed imparted to each molecule upon coming in contact with the terminal, its progress—by collision with other molecules—is retarded to such an extent, that it does not get away far from the terminal, but may strike the same many times in succession. The higher the frequency, the less the molecule is able to get away, and this the more so, as for a given effect the potential required is smaller; and a frequency is conceivable—perhaps even obtainable—at which practically the same molecules would strike the terminal. Under such conditions the exchange of the molecules would be very slow, and the heat produced at, and very near, the terminal would be excessive. But if the frequency would go on increasing constantly, the heat produced would begin to diminish for obvious reasons. In the positive brush of a static machine the exchange of the molecules is very rapid, the stream is constantly of one direction, and there are fewer collisions; hence the heating effect must be very small. Anything that impairs the facility of exchange tends to increase the local heat produced. Thus, if a bulb be held over the terminal of the coil so as to enclose the brush, the air contained in the bulb is very quickly brought to a high temperature. If a glass tube be held over the brush so as to allow the draught to carry the brush upwards, scorching hot air escapes at the top of the tube. Anything held within the brush is, of course, rapidly heated, and the possibility of using such heating effects for some purpose or other suggests itself.

When contemplating this singular phenomenon of the hot brush, we cannot help being convinced that a similar process must take place in the ordinary flame, and it seems strange that after all these centuries past of familiarity with the flame, now, in this era of electric lighting and heating, we are finally led to recognise, that since time immemorial we have, after all, always had "electric light and heat" at our disposal. It is also of no little interest to contemplate, that we have a possible way of producing—by other than chemical means—a veritable flame which would give light and heat without any material being consumed, without any chemical process taking place, and to accomplish this, we only need to perfect methods of producing enormous frequencies and potentials. I have no doubt that if the potential could be made to alternate with sufficient rapidity and power, the brush formed at the end of a wire would lose its electrical characteristics and would become flamelike. The flame must be due to electrostatic molecular action.

This phenomenon now explains in a manner which can hardly be doubted the frequent accidents occurring in storms. It is well known that objects are often set on fire without the lightning striking them. We shall presently see how this can happen. On a nail in a roof, for instance, or on a projection of any kind, more or less conducting, or rendered so by dampness, a powerful brush may appear. If the lightning strikes somewhere in the neighbourhood the enormous potential may be made to alternate or fluctuate perhaps many million times a second. The air molecules are violently attracted and repelled, and by their impact produce such a powerful heating effect that a fire is started. It is conceivable that a ship at sea may, in this manner, catch fire at many points at once. When we consider, that even with the comparatively low frequencies obtained from a dynamo machine, and with potentials of no more than one or two hundred thousand volts, the heating effects are considerable, we may imagine how much more powerful they must be with frequencies and potentials many times greater, and the above explanation seems, to say the least, very probable. Similar explanations may have been suggested, but I am not aware that, up to the present, the heating effects of a brush produced by a rapidly alternating potential have been experimentally demonstrated, at least not to such a remarkable degree.

By preventing completely the exchange of the air molecules the local heating effect may be so exalted as to bring a body to incandescence. Thus, for instance, if a small button, or preferably a very thin wire or filament be enclosed in an unexhausted globe and connected with the terminal of the coil, it may be rendered incandescent. The phenomenon is made much more interesting by the rapid spinning round in a circle of the top of the filament, thus presenting the appearance of a luminous funnel, fig. 16, which widens when the potential is increased. When the potential is small the end of the filament may perform irregular motions, suddenly changing from one to the other, or it may describe an ellipse; but when the potential is very high it always spins in a circle; and so does generally a thin straight wire attached freely to the terminal of the coil. These motions are, of course, due to the impact of the molecules, and the irregularity in the distribution of the potential, owing to the roughness and dissymmetry of the wire or filament. With a perfectly symmetrical and polished wire such motions would probably not occur. That the motion is not likely to be due to other causes is evident from the fact that it is not of a definite direction, and that in a very highly exhausted globe it ceases altogether. The possibility of bringing a body to incandescence in an unexhausted globe, or even when not at all enclosed, would seem to afford a possible way of obtaining light effects, which, in perfecting methods of producing rapidly alternating potentials, might be rendered available for useful purposes.

In employing a commercial coil, the production of very powerful brush effects is attended with considerable difficulties, for when these high frequencies and enormous potentials are used, the best insulation is apt to give way. Usually the coil is insulated well enough to stand the strain from convolution to convolution, since two double silk covered paraffined wires will withstand a pressure of several thousand volts; the difficulty lies principally in preventing the breaking through from the secondary to the primary, which is greatly facilitated by the streams issuing from the latter. In the coil, of course, the strain is greatest from section to section, but usually in a larger coil there are so many sections that the danger of a sudden giving way is not very great. No difficulty will generally be encountered in that direction, and besides, the liability of injuring the coil internally is very much reduced by the fact that the effect most likely to be produced is simply a gradual heating, which, when far enough advanced, could not fail to be observed. The principal necessity is then to prevent the streams between the primary and the tube, not only on account of the heating and possible injury, but also because the streams may diminish very considerably the potential difference available at the terminals. A few hints as to how this may be accomplished will probably be found useful in most of these experiments with the ordinary induction coil.

One of the ways is to wind a short primary, fig. 17A, so that the difference of potential is not at that length great enough to cause the breaking forth of the streams through the insulating tube. The length of the primary should be determined by experiment. Both the ends of the coil should be brought out on one end through a plug of insulating material fitting in the tube as illustrated. In such a disposition one terminal of the secondary is attached to a body the surface of which is determined with the greatest care so as to produce the greatest rise in the potential. At the other terminal a powerful brush appears, which may be experimented upon.

(To be continued.)

PARLIAMENTARY NOTES.

IN the Committee of Supply last week,

MR. LENG rose to move the reduction of the item for the Patent Office by the sum of £100. He said he did this in order to advocate the redress of a grievance which was felt to be serious by the large and important class of inventors in this country. The fees were such as might be from time to time, with the sanction of the Treasury, prescribed by the Board of Trade. The initiative in reducing the fees rested with the Board of Trade, so that if there was a strong case for the reduction of these fees and they were not reduced, the responsibility primarily rested with the president of the board. The Chancellor of the Exchequer had admitted that the receipts of the Patent Office for the year 1889 were £93,534 in excess of the expenditure. The report for the year 1890, since issued, showed a large increase on that large sum, viz., £109,366. The Patent Office for the year yielded no less than £165,000; designs, £4,500; trade marks fees, £16,400; and the sale of publications, £6,000, making a total of £192,000; while the total expenditure of the Patent Office was only £83,240. The right hon. gentleman said that manufacturers did not object to fees which had the effect of extinguishing useless patents, and that it was in contemplation to spend a considerable sum on new buildings. The Chancellor of the Exchequer had been

misinformed regarding the views of manufacturers. There had been memorials from manufacturers and inventors in Liverpool, Birmingham, Manchester, Leeds and London praying for a reduction of the fees. He had been almost overwhelmed with correspondence from all parts of the kingdom urging him to persevere with this motion. The cost of a patent in this country was largely in excess of that in any other country in the world. The British Government exacted £154 for a patent for 14 years, against £7 10s. in the United States for 17 years. Protection for four years cost only £4, but the payment of £10 for the fifth year brought that up to £14, being for five years about double the charge in the United States for 17 years. The Patent Office did nothing to ascertain or to guarantee the validity of a patent. On the other hand, the United States Patent Office for the £7 10s. it received insured the patentee a real title by a painstaking examination by the best experts. Computing the fees for the number of years for which the patents existed in the different countries, the average charge in each country was as follows:—United States, 8s. 5d. per annum for 17 years; France and Italy, £4 per annum for 15 years; Belgium and Spain, £4 4s. per annum for 20 years; Russia, £5 10s. per annum for 10 years; Great Britain, £11 per annum for 14 years. This country was far behind even Russia, our fees being 100 per cent. more than those in that benighted land, while they were 2,500 per cent. more than those in the United States. How far fees affected the number of patents was shown by the following returns for 1887, for Great Britain and the United States, respectively. Applications, 18,051—35,613; patents granted, 9,410—20,429; income from fees, £124,279—£228,902; expenditure, £81,577—£198,892; surplus, £42,702—£30,010; patent fund, none—£651,498. It thus appeared while the small fees encouraged the taking out of double the number of patents in the United States, the total amount of the fees was double that in this country, and a very large patent fund had been accumulated. This country, in effect, levied a heavy tax upon its inventors, on the men to whose ingenuity it was so largely indebted for its manufacturing and mercantile prosperity. The United States, on the other hand, made the smallest reasonable charge on the inventor, with the result that almost every American citizen was a patentee. America encouraged her poor newsboys, like Edison, to become distinguished inventors and millionaires, while the Patent Office in this country exacted fees which to many a poor man were prohibitory, and although in many cases he might scrape together the £4 charged during the first four years, he was quite unable to pay the £10, £15, and £20 per annum exacted during the remaining ten years. The right hon. gentleman the member for West Birmingham, when President of the Board of Trade in 1883, introduced a great improvement on the system which had previously existed. Under the Patent Act of 1852, the patent fee of £150 was required to be paid in two instalments of £50 and £100 respectively, which covered the patent for 14 years. Under the Act of 1883 the total sum of £154 was spread over 14 years in the following manner:—£1 was charged on filing the provisional patent, and £3 on its completion, so that for the first four years the total charge was only £4. Then from the end of the fourth year till the end of the seventh year £10 per annum had to be paid; for the next two years £15 per annum; and the next four years £20 per annum. These changes led to a large increase in the number of patents. Under the Act of 1852 the largest number of aplications was in 1882, the total being 6,241, but immediately after the passing of the Act of 1883, which spread the fees over a number of years, the applications rose to 17,110, and they had gone on steadily increasing, until in 1889 the number was 21,008. The easier method of charging the fees, although the total fees remained the same, had led to an increase in the number of applications for patents of between 300 and 400 per cent. The reason why the renewal fees were left unaltered in their aggregate amount was that it was feared that without these the administration of the Patent Office might be carried on at a loss, owing to the reduction brought about by the diminished fees. But now that it was plainly evident that there was no risk of such loss as was then feared, owing to the number of patents having increased four-fold through the easier method of paying the fees, the time had come to consider the question of renewal of fees *de novo*. Even if the fees were reduced, and reduced very considerably, there would not be a proportionate reduction of the total receipts of the Patent Office; but we should see that as the spreading of the fees over a number of years led to a large increase of applications, so would the lessening of the annual payments. Many more patents would be applied for, and many more payments made which would compensate to a large extent for the reduction of the fees. No one would object to a reasonable and prudent expenditure in enlarging the Patent Office. The accommodation at present was miserable. The library was a limbo where inventors soon lost themselves and gave up searches in despair. Much might be done to improve the arrangements. A larger staff of compilers of abridgments should be employed, so that they might be brought closely up to date. The American system of examination should be adopted to prevent duplicating and triplicating patents for the same invention. In some points the Patent Acts should be amended, especially in conformity with the valuable report made some time ago by the Chairman of the Chemical and Allied Trades Committee. With a surplus of £110,000 a year to work upon, the Patent Office might do much to encourage poor inventors by purchasing from them inventions of real utility, and making them free to the public. He did not contend for the total abolition of renewal fees, but he did say that to tax inventors £150 on each invention in a country which had so much to gain from the encouragement of inventions was most injurious, not only to the inventor, but to the country. A comparatively small annual payment during the currency of the patent should suffice, and either £3 or £5 per annum would be quite sufficient. The present system of transferring the annual surplus from the Patent Office to the Treasury was very objectionable. When so transferred, the money was lost sight of, and inventors were apt to forget how heavily they were being taxed. During the last five years these surpluses had amounted to fully £360,000. The Patent Office revenue ought to be distinctly ear-marked and appropriated for the advantage of inventors, and not thrown hotch-potch into the general revenue of the country. It was extremely inconsistent on the part of the Government to grant large sums on the one hand for technical education, and then on the other to tax those who were technically educated and were turning their technical education to good account. We should not only endeavour to fetch up our leeway so far as technical education was concerned, but we should adopt all the enlightened methods we could devise to stimulate and encourage inventors in all the arts and crafts which are the foundation of our manufacturing and mercantile pre-eminence. Instead of our Patent Office being a helpful promotor of inventions, it was a hard, niggardly, unsympathising tax collector, bent on screwing all it could out of the poor inventor, while aiding him as little as possible. In conclusion, he would respectfully urge the President of the Board of Trade, and his colleague, the Chancellor of the Exchequer, no longer to look at this question merely from the manufacturer or capitalist's point of view; no longer to look at it from the Treasury point of view as to how much the inventors of the United Kingdom could be made to contribute to the taxation of the country. Rather let them take the broader and more enlightened views which were suggested by reference to the grants in aid of technical education, by the representations which had been made in so many memorials, letters and pamphlets in the interest of inventors, advocating the reduction of these renewal fees, not merely for the benefit of inventors, but for the advancement of our trade and the prosperity of the country at large.

Sir W. HARCOURT said he should like to say a few words in support of the motion of his hon. friend, and urge upon the President of the Board of Trade to consider whether something could not be done to reduce the patent fees. Inventions were a source of National wealth and ought to be encouraged as in the United States of America, which were vastly in advance of this country in the matter of inventions, especially inventions for the saving of labour. Not so long ago certain of these fees went to the law officers, but now they went straight into the Treasury. With an annual surplus of over £100,000 the fees ought certainly to be reduced. The Patent Office ought not to be like the Post Office, which was a commercial undertaking, a source of profit to the State. Inventors as a class were poor men, and one result of these high patent fees was that in order to be able to pay these fees they were in too many cases compelled to place themselves in the hands of rich men, who secured the greater portion of the profit of successful inventions. Such difficulties ought to be removed, and he hoped the President of the Board of Trade would see his way to reducing the fees. If these were reduced by one-half there would still be a surplus left after paying all the expenses of the Patent Office.

Sir M. HICKS-BEACH observed that it seemed as if the right hon. gentleman favoured the idea of the hon. member for Dundee, that the State should buy the patents of inventors at their own price.

Sir W. HARCOURT explained that he certainly did not endorse the suggestion that the Government should buy all patents. In fact, he confined his support of the proposals of the hon. member for Dundee to the question of the reduction of fees.

Sir M. HICKS-BEACH said that in this matter the first question which the Government had to consider was, what they could afford to do. He did not suppose that the hon. member or the right hon. gentleman would argue that the cost of the Patent Office ought to be charged upon the general taxation of the country. Patentees, he thought, should certainly provide for the cost of the office. On the other hand, he did not think that the country ought to look upon the Patent Office as a permanent source of income. After the change introduced in 1883, when the Bill of the right hon. member for West Birmingham was passed, the gross receipts from the Patent Office sank to £88,000, the receipts previously having been much larger. The large increase in the sum derived from patent fees was a matter of very recent growth indeed, and in 1886 there was actually a deficit of £2,800 in connection with the Patent Office. The estimated surplus for 1891 was £116,500, and the Government contemplated very considerable expenditure for the benefit of the service. He had thought it right to examine thoroughly the buildings in which the work of the office was done, and any more inconvenient buildings, both for the gentlemen employed and the public, he had never seen. Complete reconstruction would be necessary, and it would cost fully £130,000. The money would be very well spent, because the rearrangement would facilitate a more efficient and economical administration of the office, and after the reconstruction the public, who frequented the office in large numbers, would have easier access to the specifications and to all the publications in the library. The expenditure would be provided for out of the surplus of the next two or three years. It was also very necessary to make more rapid progress with the work of the abridgment of specifications. Copies of the actual specifications were sent round to a certain number of public libraries, but only in very few places could they be turned to any public use. The public generally wanted abridgments, and to proceed with their preparation more rapidly would involve further expenditure, which must come out of the surplus from the Patent Office fees. The fact that this expenditure must be incurred being admitted, he was ready to acknowledge that there were grounds for considering whether something might not be done in the direction of the reduction of fees. It was not quite right to compare the fees charged here with those charged in the United States, and he would for one be very sorry to see the adoption in this country of the United States system, under which, by the payment of £7 10s., a patentee could obtain protection for 17 years. It was his opinion that the right hon. member for West Birmingham introduced an admirable system by the Act of 1883, when he provided that protection should be given for four years on the payment of

£4, and that if the patentee should require further protection he should be asked to make larger payments year by year, until the total period of 14 years was completed. He thought that in any scheme of revision the system of making a small demand for the first years, and of increasing the payment for the later years should certainly be adhered to. Comparison had been made between the total payment exacted in this country for 14 years, namely £154, with the payment of £77 exacted in the United States. Ours, however, was not the highest payment required to be made, for in Germany the total sum paid for a protection of 15 years amounted to £265. It had been said that these patent fees constituted a tax upon invention. He denied that that was the fact when the payment was light for the first few years. A payment of £4 for four years could not be regarded as a tax upon invention. It was a lower payment than was demanded by any other European country for protection for a similar period. His view was that they should consider whether a reduction might not be made in the fees charged in the interval between four years and eight years, so as to extend the chief protection now given for four years to a considerably longer period. He did not believe that it would be to the advantage of the public, or even of inventors themselves, that patentees should retain patent rights with regard to patents which were not worked, and which were not likely to be worked. Such retention would be as great a hindrance to invention as anything that could be imagined. If a patent was not taken up in a period of seven or eight years, was it likely to be taken up at all? If it was taken up the fees charged were trivial as compared with the profits of the successful patentee. What had to be considered, then, was the position of the patentee who did not work his patent, and he thought that what should be done was to make the fees low for a certain number of years, during which the patentee could look about for opportunities to work his patent; but they ought not, by lowering the subsequent fees, to encourage him to retain his patent rights for a longer period. He trusted that the hon. member for Dundee would be satisfied with the statement which he had been able to make.

Mr. LENG expressed his gratification at the assurance given by the right hon. gentleman that he would consider the expediency of extending the period when low fees were charged. As to the proposed reconstruction of the Patent Office he did not think that anyone would grudge the expenditure.

Mr. HOWELL said he wished to know how the work of the Labour Department of the Board of Trade was going on. He had no complaint to make with regard to the work done at that office. The only thing he had to complain of was that it took so long to do.

Sir M. HICKS-BEACH assured the hon. gentleman that this matter had by no means escaped his attention. Mr. Burnett, the chief of the Labour Department, had recently been appointed to a very honourable position—that of secretary to the Labour Commission, for which he was eminently qualified; but he had, he believed, been able to make arrangements by which that gentleman's work in the Labour Department would be carried on, so that no delay would be occasioned. The hon. gentleman would find an item on the estimates for the necessary increased charged for the Labour Department.

The vote was then agreed to.

WILLOUGHBY SMITH.

WE deeply regret to announce the death of Mr. Willoughby Smith, which took place on Friday last, at Eastbourne, where he had gone in the hope of gaining strength, but the heart disease from which he suffered was too far advanced to render that possible.

Mr. Smith was born in Yarmouth, Norfolk, on April 16th, 1828, where he remained until he took a position in the service of the Gutta-percha Company in 1848.

His connection with submarine cables, upon which his fame mainly rests, formed the theme of the two reviews on "The Rise and Extension of Submarine Telegraphy," which appeared in our issues of the 3rd and 17th insts. This recent volume, which worthily closes the list of Mr. Smith's published works, really gives the history of the author's life-long labours until he retired, owing to failing health, from the Telegraph Construction and Maintenance Company in 1887. At our first review he expressed considerable pleasure; he did not live to see the second, in which we, without knowing the end was so near, expressed the hope that time and opportunity would allow him to say something on his favourite topic of gutta-percha, a resolve at which he had hinted.

In addition to his numerous papers presented to the Institution of Electrical Engineers, with which he was intimately connected from the beginning, he had also published lectures on "Induction," "Volta and Magneto-Electric Induction," "Induction and Conduction," and "Magnetism," all of which were reproduced in the pages of the ELECTRICAL REVIEW.

Regarding his character, we think all would agree that he was singularly modest and unassuming, although naturally he had whims and fancies peculiar to himself in his own particular domain; but who is totally free from crotchets which do not necessarily make a man less beloved or respected?

He was always ready to give a helping hand to anyone he knew to be in need of assistance; in private life he was not only a good father, but also a faithful friend and companion to his children, and it is in this light that they will have special cause to mourn their loss.

His wife he only survived two months, she having expired on May 19th last, and this shock no doubt considerably hastened his end.

He leaves six children, three sons and three daughters. The eldest son takes a leading part, we believe, in the well-known firm of Elliott Bros., and the second, Willoughby, is now manager of the gutta-percha works of the Telegraph Construction and Maintenance Company.

The demise of Mr. Willoughby Smith snaps another of the few links in the chain which connect the men who in the old days were simply termed electricians, with the more modern electrical engineers, and only those who were associated with the early work of telegraphy can truly appreciate the great loss which the electrical world sustains by his death.

To write such a memoir that should do him justice would necessitate taking one's thoughts into the past and endeavouring to recall early and late incidents of those periods through which he has passed; time, however, does not allow of this and we must content ourselves with this brief outline of his long, useful and honourable career. At the funeral, which took place at Highgate Cemetery on Wednesday last, the Institution of Electrical Engineers, of which the deceased gentleman was a Past-President, was represented by Profs. W. Crookes, F.R.S., President, G. Carey Foster, F.R.S., Past-President, and the secretary, Mr. F. H. Webb.

NOTES.

Telephones in South Africa.—Telephonic communication has been established recently between Pretoria and Witwatersrand, in South Africa.

A Large Microscope.—There has just been completed at the Institute Poeller at Munich, a large microscope which is intended for the Chicago Exhibition. The microscope has an increasing power of 11,000 times.

Search Lights for the U. S. Government.—The Thomson-Houston Company are constructing six fourteen-inch projecting search-lights, to be used on the launches of the United States Government.

Electricity in Mining.—There is stated to be between 30 and 40 mines in the United States using electricity as a means of illumination or power. A furthur extension of the use of electricity in mines in the United States, is being looked forward to.

Transmission of Power.—The inauguration has taken place of a central station for the supply of light to the principal hotels, &c. in St. Moritzbad, in the Engadine. The power is obtained from the Julier brook near Silvaplana, a distance of just over three miles away, and the available water power is estimated to be 1,000 H.P. From here the water is led to the turbines along an iron pipe, 2 feet in diameter, 2,296 feet long, and having a fall throughout this length of 610 feet There are three turbines of 160 H.P. each coupled direct to Ganz alternators, and the combined output is 240,000 watts, this being capable of energising 4,500 16-C.P. lamps simultaneously. The alternators are run in parallel, and work on to a 8 mm. conductor; the regulation of the turbines is automatically effected. The current is transmitted overhead at 3,000 volts, and is reduced to 100 volts in five transformer stations in St. Moritzbad.

Personal.—Prof. William Crookes, F.R.S., has joined the board of the General Phosphate Corporation, Limited.

Messrs. D. Hulett and Company's Annual Dinner.—On Saturday last the *employés* of Messrs. D. Hulett and Company, Limited, held their annual dinner at Markwell's Hotel, Brighton. A very pleasant day was spent, the number present being nearly one hundred.

Dividend Notice.—A first and final dividend of 1s. 11d. in the pound is gazetted in the case of W. Rowbotham and Co., electrical engineers, of Salford, same being payable July 23rd, 1891, at the trustees' office, 2, Clarence Buildings, Manchester.

American Electric Mining Plant.—Messrs. Shippey Brothers, of London, are introducing a new and complete system of electric mining plant, consisting of coal cutters, rock drills, stone and granite cutters, and announce that they are prepared to either sell machines right out free from royalty, or contract with colliery owners and quarry proprietors to cut coal, stone, or granite at a fixed charge upon the output.

Carbons.—A foreign contemporary states, that the Electric Lighting Company, of Concord, N.H., is using a device by means of which a saving of 30 per cent, is effected in the cost of arc lamp carbons. All the short pieces of carbon, after being collected, are sorted and matched together to form a carbon about 8 inches in length. These pieces are then placed in a machine and cemented together. These spliced carbons, which are said to work satisfactorily, are only used in the lower holder.

Cheap Galvanic Energy.—We have been favoured with the description of a primary battery which is said to produce electrical energy at the cost of only 8½d. per Board of Trade unit. This is exclusive of labour, which is estimated to be almost nil. The inventors have only to reduce the cost a little more, when central stations may just as well shut up shop. We shall probably have more to say about this in our next, when probably the figures may be somewhat altered.

Post Office Telegraph Inspectors.—In the House of Commons last week Mr. H. S. King asked the Chancellor of the Exchequer whether a petition from the Inspectors of the Engineering Branch of the Post Office Telegraph Service, asking for consideration of the unequal terms on which they were placed by the raising of the scales of salary of superintendents and assistant superintendents of provincial telegraph offices, was sent in August last year, and whether a scheme for remedying the grievances of the men has long since been submitted by the Post Office to the Treasury, and if so will he explain why the decision on their grievances is delayed. Mr. Jackson, on behalf of Mr. Goschen, replied that he had no knowledge of the petition referred to, but he understood that the Treasury had received from the Post Office certain proposals, and these were under consideration.

Dover and the Electric Light.—The Dover Corporation really appear serious in their deliberations in connection with the proposal to introduce the electric light into Dover, where there is undoubtedly a good opening for a company, as the town is at present in the hands of one local gas company. The corporation held a special meeting this week to consider a tender from the Brush Company. There were three tenders in all, but owing to the conditions of the tendering not being adhered to, two of them were rejected, leaving only the tender from the Brush Company to be considered. This tender, however, was a little vague, as it submitted a great number of proposals and clauses, and it could hardly be called a tender in the proper sense of the word, and virtually meant that the company were willing to form a local company, or to light the town on behalf of the corporation, for which purpose they suggested that negotiations should be opened between the corporation and themselves. The meeting resulted in a determination to open negotiations with the company as suggested.

Electric Light Promoters' Profits.—Our contemporary *Money*, in an article upon the recently-floated City company, does not understand why it was necessary to invoke the aid of an "exploration company," for the purpose of raising capital. It proceeds to argue that the object is merely to manufacture promoters' profits.

The Lights o' London.—Mr. George R. Sims, of *Referee* and dramatic fame, is having his house lighted by Messrs. Rashleigh Phipps and Dawson. This is how the "Member for Slocum" humorously describes the situation:—"I have the gout turned on full at the meter. I am also having the electric light laid on at 'Mustard and Cress' Villa. I have been studying the process during my confinement to the house, and I am full of 'live currents' and '16 candle-power' and 'switches' and 'return cables.' I have a particularly live current going straight down into my right foot, and every toe is burning away at 16-candle strength. That is the gout. Up to the present my electric lighting has only got as far as lumps of ceiling coming down, and floors coming up, and walls being bored through, and a general condition of brick-dust and plaster. I have to go up and down stairs with an umbrella now, to protect my head from the showers that fall as the merry men from Berner Street (not gas-Berner Street) bore through floor and wall and ceiling, and career wildly about with half miles of red and black tubing in their hands. They seem to me to be playing at a game which is a graceful compromise between the tug-of-war and 'Here comes a chopper to chop off your head.' . . . What with the gout and the electric light I have had some difficulty in getting through my allotted task without displaying temper. I have, under the circumstances, thought it wise to avoid controversial matter. Men with the gout are apt not only to say but to write many things which they simply ignore when the attack is over. Next week I hope that the gout will be 'off' and that the electric light will be 'on,' and that I shall once more be able to discuss everything in general and nothing in particular with that perfect temper which has for so many years been the distinguishing characteristic of

"DAGONET."

Electric Lighting in St. George's, Southwark.—A letter was read at St. George's Vestry on Tuesday evening, in which the Board of Trade informed that body that they had consented to the use of an extra high pressure system in Southwark by the London Electric Supply Corporation, Limited, and had also given provisional approval of the use of certain earth connections to the system of supply adopted by the corporation, subject to certain conditions and regulations. The conditions are—(*a*) That in the event of any serious injurious affection of the telegraphic lines of the Postmaster-General resulting from the supply of energy under the abovementioned system, this provisional approval will be revoked, and the undertakers called upon to modify their system in the necessary particulars. (*b*) That the transformers and all high pressure apparatus on the consumers' premises shall be the property of and under the charge of the undertakers. (*c*) That the Board of Trade shall be the sole judges of any breach of the said conditions, or any of them. The corporation is also informed that it must be understood that—1. So soon as the amount of supply in the various portions of the district appears to the Board of Trade to warrant it, the undertakers may be called upon by the Board of Trade to establish converting stations from which a supply of energy shall be given at a low pressure. 2. On the breach of one or more of the conditions named herein, the provisional approval of the system given by this letter may be at once withdrawn. 3. The provisional approval is given subject to acceptance of the conditions hereby imposed, and without such conditions no approval of the system could be given. The Board of Trade has also sent the corporation a consent to the use by the undertakers of an extra high pressure supply, subject to conditions; and the provisional approval of the department, given with the concurrence of the Postmaster-General to the use by the undertakers of certain earth connections on their systems. These approvals are in substitution of other consents given in March last.

Tenders Wanted.—For lighting by electricity the Ladywell Sanatorium for the county borough of Salford, Mr. Samuel Brown, Town Clerk. Also for lighting certain streets in the borough of Burton-on-Trent, Mr. F. L. Ramsden, engineer, Gas Works, Burton.

South London Tradesmen and the Deptford Station.—Last week a number of tradesmen from Boro' High Street and district, at the invitation of Mr. Joel, electrical engineer, visited the London Electric Supply Corporation's works at Deptford. An official of the company and Mr. Joel explained to the visitors the system adopted by the corporation, and the machinery already erected and in course of erection, which will ultimately enable the company to supply a million lights.

Poole and White's Annual Dinner.—The second annual dinner of the *employés* of Messrs. Poole and White, Limited, was held on Saturday last at the Queen's Head Hotel, Taplow, the weather being everything that could be desired for such an event. The forenoon was spent in a variety of athletic sports, winding up with a five mile bicycle race, which created some excitement, owing to most of the competitors doubling or trebling the distance by missing their way back to the winning post. In the afternoon most of the party resorted to the river, some of the more expert rowers going up as far as Cookham. The dinner was presided over by Mr. Tryon, chairman of the company.

The Proposed Underground Electric Railway in Paris.—A French engineer, M. Berlier, has asked the Paris Municipal Council to grant him a concession for the construction of an underground electric railway in that city, on similar lines to the City and South London Railway. The railway would consist of two tracks laid in one tunnel, and the length of the line would be eleven kilometres. The Works and Ways commission recommends the council to include this scheme in its investigations concerning rapid transit in Paris.

American Technical Journalism.—Our American contemporary *Practical Electricity*, is to appear weekly in future instead of fortnightly. With the first number of this month, it has taken up fresh aims, being no longer a trade journal exclusively, but addressing to "the great public at large."

The same journal has also just inaugurated a new departure in the shape of a premium list. "In order to encourage the adoption of electrical apparatus in the home, &c.," and also to swell the subscription list, it offers premiums of useful electrical apparatus, to all those who send in the names of two or more new subscribers.

The Pilsen Electric Company.—The Pilsen Electric Company has removed its offices and works from 4, Stanhope Street, Euston Road, to more central and extensive premises, 80, Leather Lane, Holborn, E.C. The new works are being specially arranged for the manufacture of Pilsen arc lamps and all accessories for electric lighting and transmission of power. The company is preparing for the market several new forms and adaptations of the Pilsen lamp, suitable for lighting the interiors of buildings, and also an improved carbon for use with arc lamps, which shows marked advantages over the carbons hitherto used.

"Colloquial German."—We have received Mr. Swan's "Colloquial German," Phonetic Series, published by Mr. D. Nutt. As a good many English travellers will be visiting Germany this summer, the book should meet with a large demand. It certainly supplies a want. The most common every-day phrases are given in the German equivalent, and by the aid of phonetic spelling no one should have any difficulty in making himself understood. A good deal of miscellaneous information is also given as to fares, hotels, &c. The book is undoubtedly useful, and decidedly clever. We understand that Mr Swan will send a free copy to any member of the Council of the Institution of Electrical Engineers who may be visiting the Frankfurt Exhibition.

German Exhibition.—The Gülcher New Electric Light and Power Company have carried out the entire lighting of the exhibition. The installation consists of 200 arc lamps of 300 candle-power and 200 candle-power respectively, and is believed to be the largest electric light installation in England. In addition, several hundred incandescent lamps of various sizes and candle-powers are driven by the same engine. The current is generated from Battersea dynamos, and the installation is worked on the parallel system, the highest pressure exerted being about 70 volts.

The Training of Nurses in Medical Electricity.—Particulars of the summer term examination at Grafton College, Fitzroy Square, W., have reached us and we note that one of the pupils, who by-the-bye, is an M.D, obtains high honours in electricity and electro-therapeutics, and another passes *with credit* in 2nd division. The manner of conducting the practical part of the examination, is somewhat similar to that introduced in some of the City Guilds' Institute examinations. Each pupil is given a prescription and a patient, and requested to ask for the apparatus and accessories he or she may think necessary for the proper performance of the treatment prescribed. These being supplied, the prescription is carried out upon the patient in the presence of two examiners who during the process ask critical questions upon the method employed. It seems to us that if Mr. Newman Laurence and Dr. Harries, can turn out nurses trained thus in the elementary theory and practise of electro-therapeutics, medical men will find that one great hindrance to their more frequent employment of electricity removed, inasmuch as they will have ready to hand trained operators on whose qualifications they may rely.

The Société Générale des Téléphones and the French Government.—At the meeting of the Council of State, which was held on Friday last, under the presidency of M. Laferrière, the various actions pending between the State and the General Telephone Company were considered at great length. The company demanded the rescinding, as an undue exercise of power of a warrant of the Minister of Commerce and Industry, dated August 30th, 1889, which had committed the head engineer of the Paris district and the directors of the depôts of the Rhône, Gironde, Bouches du Rhône, Loire Inférieure, Seine Inférieure, Loire, Pas de Calais, Alger, and Oran for taking possession of the material of the undertaking and the offices. (This taking possession was effected on September 1st, 1889.) The company also appeals against a warrant dated February 25th, 1890, by which the Council of the Prefecture of the Seine had rejected its claims for the payment of a sum of ten million francs as damages, and had restricted the indemnity claimed by it to the amount of the profit of which it had been deprived from September 1st, the date of the seizure by the State, up to September 8th, the date on which its concession expired. The agreement of 1884, under the regulations of which the telephone company originally worked, foresaw the purchase; but the company took advantage of an agreement concluded on July 22nd, 1886, between it and the Minister of Posts and Telegraphs, which greatly modified these regulations. This agreement, in so many words, only permitted purchase after the lapse of 15 years, and fixed in advance the forfeiture conditions. The purchase on September 1st, 1889, was therefore a violation of this new contract, and it is principally on this fact that the company bases its claim for damages. This agreement of 1886, which was thus relied upon by the company, was submitted to the Chamber, and redeemed by it in 1889. But the company remembers that the State was engaged by the mere fact of the signature of the agreement by the Minister. This agreement was, according to the company, approved by a decree of July 29th, 1886, which was not published, but which (still according to the company) none the less bound it to the State. It was on the rejection by the Chamber of the agreement of 1886 that the Council of the Prefecture of the Seine relied in refusing the demand of the telephone company, the concession being revocable in virtue of the original agreement of 1844, the fact of its revocation could not, according to the Council of the Prefecture, call for an indemnity in favour of the company.

Electric Lighting at Alicante, in Spain.—An electrical installation is being erected in this town by Messrs. Siemens and Halske. The installation will comprise about 4,000 incandescent lamps. The dynamos are to be driven by gas engines.

Electric Lighting of the Prague Exhibition.—The electric lighting of this Exhibition is being carried out by two firms, Herr F. Krizik and Messrs. Waldek and Wagner, and consists of 200 arc lamps and 1,000 incandescent lamps. Krizik's installation consists of three large dynamos, each running at 350 revolutions, giving an output of about 300 ampères at 110 volts, and supplying current to the arc lamps.

Ships' Compasses.—Messrs. J. D. F. Andrews & Co. write us as follows:—"With reference to Sir William Thomson's letter, published in the notes of your REVIEW of July 17th inst., we wish to say that we take special care to keep the outer conductor of our concentric system insulated from the ship's hull. In many cases the wood parts of the ship are so extensive that it is easy to contrive that all the wires are run on wood, and where the wires must be carried on the iron of the ship a durable light insulation is provided. In the engine room stokehold and tunnel parts of the ship we have as a rule considered it unnecessary to insulate the outer conductor from the ship's iron, these parts being far removed from the compasses, and the amount of current in the wires so very small."

The Applications of Electromotors.—The latest and most improved appliances have been provided for ventilating the Goldsmiths' Technical and Recreation Institution by Messrs. Easton and Anderson, who have put down one of their improved electromotors, driving direct on to a Blackman fan, for supplying the necessary fresh air to the Lecture Halls. A "Whitehall" dynamo, Prentice's patent, is placed in the space adjoining the electrical laboratory, and supplies current to the electromotor. It has also been proposed to work the bellows of the grand organ, shortly to be erected, by electromotors controlled by the organist, with magnetic clutches. In this way a large volume of air can be obtained at the will of the player. The "Whitehall" dynamos are driven by the steam engine used for pumping and other purposes, and this will prove an interesting example of how the power may be electrically distributed for a variety of purposes through a large building.

Gas Engines and Electric Lighting.—Describing the machinery for the Bolton Technical School, the *Bolton Journal* (Saturday, July 4th), says:—"The importance of the motive power to drive the machinery and the electric lighting caused the architects to make special enquiries and investigation into the various gas engines in the market. They laid before the committee estimates and particulars from the leading makers in the country, together with the results of their visits of inspection and diagrams of working. These received the careful consideration of the committee, who decided to accept the estimate of Messrs. Dick, Kerr and Company, Limited, of Kilmarnock and London, the makers of the "Griffin" double-acting gas engines. This is the best type of a double-acting engine, and is particularly steady in running. There is an explosion at every revolution and a half, first on one side of the piston and then on the other, ensuring great regularity. It is of the greatest importance to have steady running, especially for electric lighting, and the consumption of gas in these engines is as small as in best single-acting engines. Two engines are required, each to indicate 35 horse-power. One will be used to work the machinery and the other the electric lighting, but they will be so arranged as to be worked separately for either purpose, so that any accident to either engine would not completely stop any part of the work of the school. In addition to the large engines a 3 horse-power engine will be provided, and serve as a starting engine for the large ones, and also will be available for use when it is required to run only a small portion of the machinery. This will enable students to use some of the machinery for special purposes without the necessity of running the large engines, and will be a great convenience in the effective working of the school."

Electric Companies and Vestry Contractors.—The London Electric Supply Corporation, Limited, have for a few weeks past been engaged in a little conflict with St. George's Vestry as to whether they should be compelled to employ the vestry's contractor to repair trenches they had opened for the purpose of laying their mains. They have claimed that they should be allowed to employ any asphalter they choose, and the vestry has refused to allow the claim. A considerable amount of correspondence on the subject was read at the vestry on Tuesday. A further letter was also read from the London Electric Supply Corporation, in which they give the vestry a list of trenches to be reinstated, and the secretary adds: "I hereby further give you notice that this voucher is given under protest, and saving to the London Electric Supply Corporation, Limited, the right to question any charges in respect of restoring the surfaces of footways and carriageways which may be in excess of those which would have been incurred had the corporation been allowed to employ their own contractor." Mr. Thornton, L.C.C., said it was very necessary that the officials of the vestry should keep a sharp eye on the electric lighting companies. He gave this caution in consequence of information he had received in his capacity as a councillor. The Surveyor reported that the London Electric Supply Corporation were driving their mains under the tram lines in certain portions of Newington Causeway. They had received no permit from the vestry to do so, and their plans did not show they intended to take such a course. He had written them on the subject. The vestry will await the company's reply.

NEW COMPANIES REGISTERED.

Italian Electrical Light and Power Company, Limited.—Capital, £60,000 in £4 shares. Objects: To acquire electrical installations, concessions, grants, lands, plant and property of every description in connection with electricity; to carry on all kinds of business connected with the generation, supply and use of electricity for the purposes of light, heat and power; to investigate and report on electrical and other projects and enterprises, and to act as inspectors and managers of electrical installations, water and other works. Signatories (with 1 share each): Girolamo Taddei, 83, Arenula, Roma; Pietro Alessandri, 92, Via dei Farnesi, Roma; J. Reid, 101, Leadenhall Street, E.C.; C. E. Stuart, 4, Aberdare Terrace, Highbury, N.; A. P. Windridge, 344, Stanstead Road, Catford; T. Wholey, 7, Storeys Gate, S.W.; J. Carr, 35, Paget Road, Stoke Newington. The number of directors is not to be less than three nor more than eight. Qualification, 25 shares. Remuneration equal to £50 each per annum. Registered on the 17th inst. by A. W. Rixon, 10, Austin Friars, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Stamford Hill, Tottenham and Edmonton Electric Light and Power Supply, Limited.—At an extraordinary general meeting of the members of this company, held at Westminster Chambers, 5, Victoria Street, Westminster, the offices of the company, on the 3rd ult, and at a subsequent meeting held on the 24th ult., the following was passed and confirmed, "That the name of the company be changed to the Putney and Hammersmith Electric Light and Power Supply, Limited." The approval of the Board of Trade to the change in the name of the company was granted on the 1st inst., and filed on the 6th inst.

Shropshire Electric Light and Power Company, Limited.—The statutory return of this company, made up to the 12th ult., was filed on the 19th ult. The nominal capital is £25,000 in £10 shares. 275 shares have been taken up, but on these no call has been made. The total amount of allotment money paid is £510, and unpaid to £40. Office, 9, The Square, Shrewsbury.

City of London Electric Lighting (Pioneer) Company, Limited.—The statutory return of this company made up to the 8th ult, was filed on the 20th ult. The

nominal capital is £100,000 in £50 shares. 1,000 shares have been taken up, upon each of which £25 has been called and paid. Office: 1 and 2, Great Winchester Street, E.C.

Automatic Electric Railway. Signal Company, Limited.—A meeting of the above company was held on the 22nd ult., for the purpose of having an account laid before them showing the manner in which the winding-up had been conducted and the property disposed of, and the same was done accordingly. Office: 6, Rumford Place, Liverpool.

CITY NOTES.

Eastern Telegraph Company, Limited.

THE thirty-eighth half-yearly ordinary general meeting was held on Thursday, July 16th, at Winchester House, Old Broad Street.

The SECRETARY read the notice convening the meeting, and also the minutes of the previous meeting.

The CHAIRMAN (Sir John Pender): Gentlemen, you have had the report in your hands some days, and I presume you will take it as read. It is a very full one, and anyone who reads carefully can quite understand the movements of the company generally, and also as to two or three investments which you generally approve of; but, as usual, I shall go over the report and accounts, and refer to some of the leading points in it. The receipts for messages for the six months ending March 31st, 1891, amounted to £349,749, as against £348,624 for the corresponding period of 1890, showing an increase of £1,125. The total working expenses for the half-year ending March 31st, 1891, amounted to £102,020, as against £98,477, an increase of £3,543. Included in this year's figures, however, is the item of station repairs to Alexandria Buildings, £3,825, to which I referred at the last meeting. Several of the items show an increase, while others show a decrease. Details are as follows; but, before passing on, I think I may say that the Alexandria Buildings is a very fine block of buildings indeed, but unfortunately dry rot got into the building, and we had to take out the rotten beams and put in iron beams—in other words, we had to make a very effectual repair at our Alexandria establishment, which is a very large place, and in which we have to put up our staff. It is a great credit to the company, and it is one which we consider absolutely necessary to put into a thoroughly effective state, both as to soundness of building and sanitary state as well, which is very much required. We have also in this block of buildings a number of shops which we let off, and altogether it is a building which the company have every reason to be satisfied with. The general expenses in London are £9,503 against £8,726, or an increase of £777, the principal being in advertising and stationery. The working expenses at stations amounted to £75,003 against £72,677, or an increase of £2,526. The necessary increase in this particular, and the additional pay and allowances granted to some of our former staff—which I referred to at the last meeting—accounts for the increase. The amount carried to the reserve fund is £3,056. We have carried a smaller amount to the reserve fund this year than we did last, because our ships have, I may say, been put into thoroughly efficient order. We have had four ships in London at one time, which is a very remarkable thing indeed. I wish that we could have kept them there, as there is no place where they are better employed than in dock doing nothing. At the present time we have two ships in dock, we had three, and they are all in good order. I am pleased to say that they are at any moment ready for work. We would very much rather have no accidents to our cables and the ships unemployed. At the same time, however, we keep them in such condition that they can be employed after a few hours' notice. The staff endowment and assurance is £2,366 against £1,688, or an increase of £678 up to the end of last year. A certain number of our staff have taken advantage of this assurance scheme. The directors, however, after ten years' experience of its working are so convinced of its benefits conferred on the staff that they urge the remainder to join. I am pleased to say that nearly the whole of the staff are contributing members. Most of our Government offices and other important institutions generally make some arrangements whereby their staff are provided for. Above all things, it is necessary in a telegraphic system to have an efficient staff. We try to get the best men, and we can only keep them by making them as comfortable as possible. That is our policy, and so far we have been successful. Now, men at 50 years of age can retire with a certain sum of money in their pocket if they choose to join in the system, because a man of 50, as a manipulator, is not as valuable as young men of 21, whose fingers are lighter and more flexible altogether, and consequently they have an opportunity of retiring with a certain sum of money in their pocket. The expenses attending repairs and renewal of cables amounted to £53,144, against £47,820, an increase which is a little over £5,000. On referring to abstract C of the report, full particulars will be seen of the work performed by the ships during the half-year. The chief expense has been incurred in connection with the Red Sea cable laid in 1870. We have succeeded in removing the known weak parts, and it is believed that this line, which has been working since the formation of the company, can still be kept efficient for a number of years, thereby increasing the security of telegraph communication in the Red Sea. It is also encouraging in this way, too, that there was a time I remember when people said 10 years was the life of a cable, and then it came up to 15 years. Here is one that has been working for 21. We have taken out the weak parts and put in strong parts, and the result is that we find in it a thoroughly efficient cable, and perhaps experience will teach us that a cable may live for a time considerably over the 21 years. All that, gentlemen, is for the benefit of our company. After providing for all expenses and interest charges against revenue, we are able to recommend a final dividend at the rate of 5 per cent. per annum, and of a bonus of 1½ per cent. for the year ended 31st March last, and carried £95,000 to the general reserve fund, which amounts to £534,650, after an appropriation of £100,000 to the cost of Suez-Perim-Aden No. 4 cable. I think you will agree with me that this is a very satisfactory state of things, and I think, as I go on, I shall be able to show you that the policy we have pursued, and the reserve fund, has been able to make us hold the commanding position that we do at the present moment. Having dealt with the revenue expenses, I will now give you some information about the capital expenditure on new cables and financial arrangements. I think it is better—and my colleagues agree with me—that the more we can tell our shareholders of our policy, and the stronger we are a board and the shareholders acting in perfect harmony and accord, makes a concern much more thorough and prosperous. At the meeting in July last year, I showed you the necessity of laying a new cable in the Red Sea from Suez to Perim, and from Perim to Aden, which cost us about £250,000. At the general meeting in January last, you were informed that in anticipation of the largely increased traffic with Australia, consequent on the reduction in the rates between Australia and England, we decided to lay a triplicate cable between Aden and Bombay of such a capacity as would give us a considerable margin to deal with any increase in traffic that might take place in the next few years. It has been our policy to keep ahead of the carrying requirements of the company, and it is satisfactory to be able to say that the encouraging results of the traffic since the reduction of rates to Australia has fully justified the prompt action of the directors. We have considered it advisable to duplicate the connection with that part for cutting into No. 2 Suez-Aden cable, and this caused the laying of about 226 miles of new cable. Notwithstanding these important and expensive operations, we do not propose any permanent addition to the capital account whatever. We hope to be able to meet this expense by appropriation from time to time out of the reserve fund. Then the importance of what I am speaking about, of keeping down our capital and keeping up our power to pay you annual dividends such as we have done, I think is the policy which you must all approve of, and that is the policy which I may repeat again is the great strength of this company, as I shall show you further on. We have duplicated nearly every cable, and with the temporary assistance of the Eastern and South African Companies, in which we hold $\frac{5}{6}\frac{5}{0}$ths of the share capital, we shall be able to meet the payment due without disposing of our reserve fund investments to any large extent. The financial transactions will take about four years to complete, and it is estimated at the end of that time our position will be as follows. Additions would have been paid for, and the total amount supplied out of the reserve fund, the Eastern and South African will have been repaid, and the capital account will stand practically at the same figure as at present, providing there are no further extensions of our system. It is reckoned that the amount taken out of the reserve fund from time to time up to the date of the completion of these arrangements will be about 1½ millions sterling, and the balance of reserve remaining about half a million. It is hardly necessary for me to say the company will in consequence be even in a better financial position than it is to-day. I may mention, however, that there have been increases and decreases in one or two small items. Speaking of ships, the chairman showed that they were constantly employed, and that without them they could not possibly exist. Continuing, he said, we have got nearly all our cables duplicated. As I say, we have got four cables betwixt Suez and Aden, and three between Aden and Bombay. These are very important sections, and altogether we have now a mileage of 26,093 miles as against, in 1870, 8,434 miles, and this large addition from 8,000 to 26,000 has been done without in the slightest degree interfering with your dividends, which has been taken out of revenue, and at the same time we have materially added to our reserve fund. I think that is the state of things regarding the property, which is very difficult indeed to beat. Now, gentlemen, I have given you certain details there, which you will be able to carry away in your minds, and the last that I refer to is one from which you will see that your property has been very safely guarded and protected. Now I may refer to one item, that in our African traffic alone this last year it is something like £49,000 less than it was two years ago. Two years ago there was a great deal of excitement, as you are aware, in Africa, and money went very freely. Communication betwixt Africa and the Cape and Kimberley was very active indeed. I cannot tell you the number of mining companies which were established in London, but all these were more or less in connection with Kimberley, consequently we got a very considerable amount out of that particular traffic. For the moment that traffic does not exist, but there has been a growing traffic all the same. A legitimate traffic has been steadily growing. Population has been increased through that speculation, and the time will come round—for there are cycles of activity as well as cycles of rest—and I think the cycle of rest is prevailing at present, and we look forward to a time when the active spirit will revive, because it is in the hands of Englishmen to a great extent, and there is no doubt at all that the Cape is one of the future countries to which we have got to look to, not only for gold, but also for a largely increased consumption of British merchandise. Another point I think I may mention, which is interesting to you is, that these African cables in a certain period belong practically to the Eastern Company. At the end of that period we shall have redeemed or paid for these cables, and have them in good working order, and they will then be the property of the Eastern Telegraph Company. That will be an item which, when

the time comes, will be one which I think will add largely to our producing power, and without in any way increasing our capital. Now, gentlemen, might I tell you that we have put our cables into thorough efficient order, believing that the reduction of the rates to Australia was going to bring a very large increase. Although we have only been working three to four months, the increase up to the present has been very satisfactory. We have not recouped ourselves entirely, and I do not think we shall within about 18 months or a couple of years, but I think I may say we have so far recouped ourselves that when the end of the year comes we are very likely to go on with the experiment. The Cape has applied for the same terms, but that requires some consideration and some negotiation. I should like to see one experiment fairly tested before we enter upon another, and in the meantime, as things are not so very active in the Cape, I hope, and I believe at the same time, that this must eventually come. I can only say that when it does come it will give us what I call a guarantee for our dividend, and that will add materially to the value of our shares; at least, that is my impression. When I last addressed you, I told you that I was going to visit some of our stations in the Mediterranean. I visited them in May last, and I am not the only person who says they are most creditable to the English Company. Everyone who has seen them says they are excellent stations generally. We have got a good class of young men and the establishments are carefully conducted, and, altogether, I think that we ought to be proud of the way in which our business is conducted in the Mediterranean. I went from Egypt to Constantinople, where I found a very great disposition on the part of the Turks to keep up friendly relations. We are opening negociations there which are proceeding, and I hope eventually we may be able to lay before you statements showing the relations between the company and the Porte Government, which will promote business as well. I went to Athens and found the King of Greece very much interested in our affairs. I was assured that the way in which your business was conducted was entirely satisfactory to the governments there. Now, gentlemen, I have given you pretty well all the particulars that I desire to communicate to you, and with those remarks, I beg to move that—"The printed report and accounts of the directors to March 31st, 1891, submitted to this meeting, be, and the same is hereby adopted, and a dividend on the preference shares of the company at the rate of 6 per cent. per annum, free of income tax, be paid, and in accordance with the recommendation of the directors' report, the dividend be, and is hereby declared, of 2s. 6d. per share, with a bonus of 3s., both free of income tax, on the ordinary shares of the company, making, with the previous payments, a total payment of 6½ per cent. for the half-year ended March 31st, 1891."

The motion was seconded by the MARQUIS of TWEEDDALE.

The CHAIRMAN invited questions before putting the resolution.

Captain GOODSALL said that the chairman had mentioned the staff endowment fund. Might he suggest that the commanders of the ships should have the same privilege.

Sir JOHN PENDER: I think some of them are here, and I think they will tell you that they are pretty well satisfied with their position. I had a voyage some time ago across the Atlantic, and the captain of one of these ships said: "If you will only take me into your service, I will consider it a great honour to serve you." He thought if there had been any complaints made on the part of the commanders, Sir James Anderson would have brought the matter before him. In further reply to this shareholder as to the last Aden-Bombay cable, he said that they would give them credit, after long years' experience, that they laid the cable in what the engineers thought the best place. These matters are very carefully considered. They have not only been discussed by our own experts, but we have the advice of trained engineers, that is of the leading engineering house in London—Clark, Ford and Taylor. They represent the interest outside the board, and we put under their charge the cables, so that, apart altogether from the way the board deal with it, just as we have auditors to look after accounts, so these engineers look after the practical part of the business. I think, gentlemen, I have answered all that is required.

Capt. GOODSALL wanted to know where the cable was laid—to the north or the south of the existing one.

Sir JOHN PENDER: It is to the south.

The resolution was then carried unanimously.

Mr. GRIFFITHS, in proposing a vote of thanks to the chairman, said that on looking into the report they must thank the chairman and board for the policy which they had pursued. It was gratifying that the improvements were paid for out of the reserve. Their shares were improving in value and business was increasing, and if this dividend continues he thought they had good cause to thank those who had brought about the desirable results. He had great pleasure in proposing a vote of thanks.

This was seconded, and

Sir JOHN PENDER, in replying, said: I beg to thank Mr. Griffiths for the way in which he has proposed a vote of thanks to me. We have endeavoured to carry on this business in a way which would be not only satisfactory to our shareholders for the moment, but also to make it an entire success, and so far as I can see our policy has been eminently successful in that direction. I do not suppose at the present moment there exists a more complete system of submarine telegraphy. In fact, it is impossible. It is the most complete system of telegraphy that yet exists, and we hope to think of it still as the first system. I would just say one word. We have only come of age to-day; now it is 21 years only since this company was established, and in that period we have almost touched every part where the British flag flies. That is a work done in 21 years, in which you have helped us with your money. We who have carried it through ought to be very well satisfied and contented, and I hope our manhood will be used as advantageously as our youth has been.

This terminated the proceedings.

Crompton and Company, Limited.

THE third report of the directors, to be presented at the annual general meeting of the shareholders at the City Terminus Hotel, Cannon Street, in the City of London, on Wednesday, July 29th, 1891, at 2.30 o'clock p.m., states that the business of the company continues to increase, the order book is well filled, and negociations are on foot for several important central station contracts, in addition to those at present in hand.

The directors have given considerable attention to improved arrangements at the Chelmsford works for increasing the output, so as to ensure punctuality in the execution of orders. The fitting up of the London works, referred to in the chairman's speech at the general meeting last year, has also been completed. These alterations and additions have entailed a rather heavy outlay on capital account.

Mr. J. F. Albright, one of the managing directors, has been on an extensive tour through Canada, the United States, Australia, India, and the Cape, visiting the different agents of the company and making arrangements which it is hoped will lead to a considerable extension of the company's business abroad. The date appointed for the meeting of the shareholders has been delayed to allow for Mr. Albright's attendance on his return to England.

The net profits of the year amount to £13,030 14s. 7d., and after providing for the debenture interest and other payments set out in the revenue accounts, and deducting the interim dividends already paid on both the preference and ordinary shares, there remains, with the £474 18s. 10d. brought forward from last year, a balance available for dividend of £6,484 18s. 10d.

The directors propose, after setting aside a sum of £500 as a provision for doubtful debts and contingencies, to declare a dividend of 3s. 6d. per share, making 7 per cent. per annum upon the preference shares, and 5s. 6d. per share, making, with the interim dividend, a total of 8 per cent. per annum upon the ordinary shares, carrying the balance forward.

Sir Charles Grant has retired from the board, and the directors have elected Mr. H. H. J. W. Drummond and Viscount Emlyn to fill this vacancy and that caused by the death of Viscount Torrington, mentioned last year.

In accordance with the articles of association, Mr. B. Gibson retires from the board of directors by rotation, but offers himself for re-election.

The auditors, Messrs. J. H. Duncan & Co., also offer themselves for re-election.

STATEMENT OF LIABILITIES AND ASSETS at March 31st, 1891.

CAPITAL AND LIABILITIES.

	£	s.	d.	£	s.	d.
Authorised issue 28,000 shares at £5	140,000	0	0			
Ordinary shares, 8,000 issued as fully paid	40,000	0	0			
Preference shares, 20,000 at £5 ...	100,000	0	0			
				140,000	0	0
Debentures issued				31,050	0	0
Loan from bankers				10,000	0	0
Sundry creditors				31,317	13	2
Doubtful debts and contingencies account				464	13	5
Reserve fund				568	0	0
Revenue account balance				6,484	18	10
				£219,885	5	5

PROPERTY AND ASSETS.

	£	s.	d.
Freehold property and ground rents	19,309	2	1
Stock-in-trade, plant, tools, furniture, fixtures, &c. ...	66,903	2	9
Installations (including balance of working account to March 31st)	13,265	5	7
Trade debtors	47,299	19	9
Investments in shares of other companies	16,751	0	0
Loans at interest to subsidiary companies	6,905	8	11
Cash at bankers and in office	8,941	6	4
Preliminary expenses—suspense account	500	0	0
Patents account	10,010	0	0
Goodwill	30,000	0	0
	£219,885	5	5

PROFIT AND LOSS ACCOUNT for the year ending March 31st, 1891.

Dr.	£	s.	d.
To Trading and office expenses, salaries, agencies, &c.	17,058	3	0
„ Repairs to buildings and plant	1,532	11	8
„ Depreciation of plant, machinery, patents and fixtures	2,087	4	7
„ Balance carried to revenue account	13,030	14	7
	£33,708	13	10

Cr.	£	s.	d.
By gross profit from trading account, pupils' premiums, profits, and dividends on investments...	33,708	13	10
	£33,708	13	10

REVENUE ACCOUNT.

DR.			£	s.	d.
To Interest on debentures and mortgages			1,019	5	5
„ Preliminary expenses (written off)			338	5	0
„ Directors', Trustees', and Auditors' fees			1,111	11	4
„ Interim preference dividend paid December, 1890	3,406	5 4			
„ Interim ordinary dividend paid February, 1891	975	0 0			
„ Income tax	170	7 6			
„ Balance available for present distribution	6,484	18 10			
			11,036	11	8
			£13,505	13	5

CR.			£	s.	d.
By Balance from last year			474	18	10
„ Net profit from profit and loss account			13,030	14	7
			£13,505	13	5

The Edison and Swan United Electric Light Company, Limited.

THE eighth annual meeting of this company was held at the Westminster Palace Hotel, Mr. J. S. FORBES presiding,

The Secretary and Manager (Major S. FLOOD PAGE), having read the notice convening the meeting,

The CHAIRMAN, in moving the adoption of the report, said: I do not know if any gentleman present has thought of the agreeable exercise in which I engaged myself during the past 24 hours—that of reading all the reports of the company from the time we began business in 1884. I discovered that all the reports were very full—that a great many of the paragraphs were very long. I have been conversant with the reports of different companies for a good many years, and I have found it characteristic that in those cases in which the dividends were short the reports have been long, and *vice versa*, which seems to indicate this, that when a company has emerged, as we have done, from its early difficulties and trials, there is very little to say. It is acts, then, not words, that help you on. Happily for us, our reports have gradually diminished in length as our dividends have increased in amount. The report before you is the shortest we have ever had, as I hope you will think it the most satisfactory. It records one or two primary things of some importance—viz., that the bulk of our business has increased, and that on account of that increase we have been enabled to dispense to the "A" shareholders, on account of arrears accruing, a larger amount than last year or any preceding year. That is the whole story. As I said on the last occasion, this class of business paying a large dividend is rather a novelty for me. I have been apologising for so many reports and accounts that when there is nothing to say I am rather nonplussed. The whole story lies in the figures which, in the case of joint-stock companies, are not given so fully as those which I am in the habit of dealing with. The essence of those figures in this case lies in the profit and loss account. The first item is sale of lamps, fittings, royalty on holders, &c., £143,229. The corresponding heading last year revealed £118,865, so that the amount on our sales has increased by £24,634. The next item is £427, as against £1,442 last year, a diminution of about £1,000, arising from the fact that last year we realised certain bonds of a company which paid 4 per cent. until we took the bonds over and converted them into money. Another item which we deal with as income is that which represents stock in hand. We are bound, as I have many times explained, by the very nature of our business, to keep a large amount of money locked up in stock. We have one or two types of lamp of 16 candle-power, and some smaller lamps, which constitute the main part of our business. But there are a great many lamps of other types, and those types themselves are subdivided into other types of more or less power, and in order to suit our many customers, and the varying conditions of some of them, we are obliged to keep a large supply of lamps ready for delivery on call. The months of June and July are the slackest for electric lighting; but we must have sufficient provision for the darker days. It would not do at all to be postponing the manufacture of lamps until the moment they are wanted. Last year the stock amounted to £56,266; this year it stands at £59,308. This is a large sum to be locked up in any business; but I must qualify my remark by stating that a considerable amount does not represent lamps at all, but platinum. In the face of the possibility of a great rise in the price of platinum, we had foresight enough to secure a large quantity of it; and, as I told you last year, the price we gave was subsequently greatly exceeded in the market. We have now about £16,000 worth of platinum; the rest of the item is made up of lamps and manufacturing material, which must be restored from time to time. Now, turning to the opposite side of the account, you will find that the cost of production—I am dealing with the stock in hand on July 1st, 1890—has been increased by £3,042. Wages, purchases, &c., amount to £56,362. That represents the manufacturing cost of the factory. Wages is a thing which, as we know, do not diminish; purchases mean the material of which the lamp itself is formed—platinum, glass, carbon, &c. Then come salaries, directors' fees, general charges, &c., and depreciation of plant. The latter item, you will see, we have written down to £2,160, which we consider to be a safe quantity, being an excess of £300 on last year. The balance is £72,905, as against £61,115 last year. That is the result of the trading of the year. I do not know whether you will consider it a satisfactory result, but we think that £11,000 more profit is a good indication of the state and value of our business. An output which leaves so considerable a profit as £72,905 is not bad business. It enables us to recommend the payment of a dividend, to which you are entitled, of 17 per cent. in preference to the deferred shareholders. The outside world may believe that 17 per cent. is what may be called the normal condition of this company. It may be just as well, then, that I should mention that in 1884 we paid nothing; in 1885, nothing; in 1886, nothing; in 1887, nothing; and in 1888, nothing. It was only the confidence of the directors in the soundness of the concern, and your confidence in the directors, which carried us through the difficulties of all those years in the face of nothing to divide. That confidence has been justified by results. Once the things were settled, once the company was set upon its legs, then the business began to pay. It was only in 1889 that we, for the first time, found it prudent to pay a dividend—we then paid 10 per cent., in 1890 we paid 15 per cent., and now we propose to pay 17 per cent. That seems a very large dividend, which will, no doubt, excite the cupidity of certain people; but it works out at 5 per cent. per annum, which, I think, is not too great a reward for an enterprise of this kind. That is the outcrop of that part of the business. I may mention that our share capital remains intact—I mean that it has not altered, the total being £471,298. Now, one of the first items on the debtor side which admits of comparison is sundry credit balances. You owed last year £26,257; this year you owe £14,706. Our volume of trade has been so much larger that, at the end, we have been able to work our business and to owe less money, and, at the same time, to transfer a sum to the reserve fund, which is now brought up to £12,689, as compared with £4,495 last year. We have not divided close up. We thought it prudent, after providing 7 per cent. on the current year, to complete the payment of arrears in respect of the cumulative preference dividend for 1885 at the rate of 3 per cent., and to pay 7 per cent. on the arrears of cumulative preference dividend for the year ending June 30th, 1886. We have, however, the years 1887 and 1888, in respect of which you have had no dividend, still remaining as a charge on the future. Going to the other side of the accounts, you see items, cost of patents, goodwill, preliminary outlay, &c., and further expenditure thereon, £233,064. That further expenditure has reference to legal expenses connected with the founding of the company and the development of it. Against that we wrote off from time to time the amounts realised by the sale of plant out of date and superfluous, forming part of the original foundation price. That brings the amount down to £234,638. The amount of "B" shares of this company, issued as per contra, is £117,820, and then there is the Manchester Edison-Swan Company, Limited, £100,000 "B" shares at nominal cost, £12,000. That is the deferred interest we have got; whether it will be worth that amount in the future of the company time alone can reveal. Then you come to the item freehold property, £45,012, as against £33,306 last year, and plant and stock, £83,188, as against £77,000 last year. In order to meet the great pressure of business at our factory we have been obliged to extend it considerably by putting up new works. The money represented there is £45,000; and I think you must say that we bought the property very cheap. I have no hesitation in saying that if it were valued to-day as an established and going concern the estimate would be a vast deal more than £45,000. If we had had to buy land and build a factory we could not have done it for the money; but, fortunately, we found ample land with a structure upon it. The people who had had the property made an enormous loss, and so we were able to buy cheap. Our debtors last year were £15,203; this year they are £34,859. The debtors are all good, and represent about double the amount we owe. We have cash at bankers and in hand, £8,051; and that is an end of that part of the business. I now come to the appropriation of the £72,905 profit. After deducting the sums transferred to capital account to meet loss on realisation of original dynamo account, there remains £69,479. We took over a quantity of machinery, installations and all sorts of things, the fruit of the want of knowledge of the two original companies—the Edison and the Swan. They made a lot of bad bargains, and bought a lot of stuff which turned out to be effete, such as dynamos and installations. They had a theory that the rental of light was a very profitable thing. The theory was very good in itself; in practice it was found to be very bad, exceedingly ruinous in cost. We held that it was wisdom to cut our first loss, but these other men were such babies that they hesitated to realise their loss at the right moment. We realised our loss, and we got rid of the things on the best terms we could make, and you have now heard the last—the very last—of it. We had a lot of dynamos which were useless to us, but we managed to sell them in Italy. The other day we got rid of them all. Now, I think you will agree that the explanation of the recommendations which the directors make in their report is going far enough. I have given you the bare bones of the account, but there is just one thing I should like to call your attention to. We are face to face with this: there is so much capital—a large sum of money—and patents are running out. And then the future? One looks with some anxiety upon a past of the kind we have gone through. The cost of patents, goodwill, preliminary outlay, loss on working, &c., as per last balance-sheet, is put down at £234,638. Well, that is a considerable amount, but I do not think it is an amount you should be alarmed at. It is the cost of founding this business and carrying it through to the point when we shall be in competition with all the world; and it would be silly if we could not boast that we have, as I believe we have, the most perfect lamp factory in this or any other country, and the highest reputation of any lamp business of any kind. We have all the perseverance, all the exceeding skill on the part of our technical advisers, and all the zeal on the part of officials and directors to establish a going concern on a very large scale. But this is a large business, and

cannot be carried on on a large scale without the investment of a great deal of money, and, therefore, the people with whom we are going to compete should know that they, on their part, are going to compete with a company thoroughly equipped, high in reputation, and firmly established. We must, of course, take our chance of the future; but it comes to this, that when you have enormous risks to run, when it is a question whether success will attend you or not, when you have a protected position all the world over, blatent people may cry out about monopoly; but if you are able to make as good a lamp at prices below that of any small maker, or, indeed, any considerable maker, you can take your chance with the public.' For instance, Huntley and Palmer's biscuits—good connection, cheap production, and quantity. I know we can double and treble our sales if we can afford to take a modest profit on the output. Major Flood Page has called my attention to the fact that we are not dependent altogether on our lamp patents, but that we have licensed patents in respect of very important parts of lamps, which extend a long way beyond the lamp patents, and which yield a very valuable income in the shape of royalties. Now, I have given you the results of the working of this concern. We have to be very cautious about going into details. We are obliged, as a joint-stock company, to submit to you in black and white certain details which prosperous people in the management of their private affairs would keep to themselves. We are obliged to keep a great deal to ourselves; for, no doubt, there are many who like to know how and where we make our profit. They may induct as much as they like, but induction is not as good as positive information. Therefore we have good reason for going only into generalities. Roundly, you have diminished claims whilst you have improved your investments, which may be put down at something like £125,000. I think that that fact, coupled with the dividends you are getting now, is not altogether discouraging. With these remarks, I beg to move the adoption of the report and accounts, subject, of course, to our readiness to go into any matters or to answer any questions that may be put.

Mr. F. R. LEYLAND seconded the motion.

Mr. B. PELL wished to know if all the lamps made by the company bore the names Edison and Swan.

The CHAIRMAN said the bulk of the company's lamps were made by themselves. A few were imported from Mr. Edison, and those he supposed were marked Edison. He hoped that if any shareholders came across lamps that were not marked Edison and Swan they would intimate the fact to the secretary, so that the directors might consider what steps ought to be taken.

Mr. PELL remarked that in going through the country he had seen many lamps that were not marked at all.

The CHAIRMAN said it was just as well that it should be generally known that every incandescent lamp ought to bear the words "Edison and Swan."

Another SHAREHOLDER asked how many lamps had been sold to produce the profit given in the balance sheet.

The CHAIRMAN replied that that was a bit of information he would not be justified in giving, since it would be very useful to their opponents. The company had a great diversity of lamps sold at various prices; but it would not be to their interest to reveal any particulars.

Replying to compliments from shareholders, the CHAIRMAN said the policy of the directors had been to make things safe rather than pleasant.

The report was then unanimously agreed to.

The CHAIRMAN then moved the payment of the following dividends on the "A" shares, free of income tax, to be distributed as follows:—(*a*) At the rate of 7 per cent. per annum for the half-year ending June 30th, 1891, making 7 per cent. for the year; (*b*) 3 per cent. in completion of payment of arrears of cumulative preference dividend for the year ending June 30th, 1885; (*c*) 7 per cent. in payment of arrears of cumulative preference dividend for the year ending June 30th, 1886, which would absorb £47,719, leaving £9,388 4s. 9d. to be carried to the reserve fund.

Mr. LEYLAND seconded the motion, which was passed unanimously.

Mr. J. S. Forbes and F. R. Leyland were re-elected to the directorate, and Messrs. Welton, Jones & Co. were reappointed auditors.

The proceedings closed with the usual vote of thanks.

Direct United States Cable Company.

SIR J. PENDER presided at the ordinary meeting of this company, held on Friday at Winchester House. In moving the adoption of the report the chairman said the revenue for the half-year, after deducting outpayments, amounted to £37,352, and the working and other expenses, including income-tax, but exclusive of cost of repairs, absorbed £18,112, which left a balance of £19,240 as the net profit for the half-year, making, with the amount brought forward, a total of £24,750. This had been appropriated as follows:—To an interim distribution of 3s. 6d. per share for the quarter ending March 31st, and a proposed final dividend of a similar amount, leaving £3,502 to be carried forward. The revenue for the half-year had shown a falling off of £2,664 as compared with that of the corresponding period of 1890, which was due to slackness of business, partly owing to the recent fiscal arrangements of the United States and the temporary loss of traffic in consequence of the war in Chili. The expenditure in London remained practically the same, while that at the stations had increased by £468. The cost of repairs during the period under review had amounted to £2,188, which had been charged to the reserve. On the other hand, that account had been credited with £4,365, interest on investments, thus giving a total of £254,854. The company was participating, to some extent, in the evils resulting from the cloud which was hanging over commercial enterprise. Telegraphy was a good barometer; with a buoyant trade they had a buoyant traffic, and *vice versa*. Notwithstanding all the difficulties and troubles that had surrounded submarine telegraphy in the Atlantic for some time past, he thought he might say with perfect safety that there was no company at present which occupied a better position than the Direct United States Company. The world could not do without submarine telegraphy, and this communication between the old world and the new must always be a growing factor of civilisation.

The report was adopted.

Venezuela Telephone and Electrical Appliances Company.

THE directors have issued a report stating the half-yearly interest on the debentures due on the 31st inst, will be paid on presentaton of the coupons on and after that date, either in Amsterdam or at the Consolidated Bank, Limited, London. The following figures, which point, as will be observed, to a steady growth of the company's business since its incorporation, and to its success in the future:—The earnings have been as follows—To December 31st, 1890, £9,028 gross, £3,495 net; for January, 1891, £1,120 gross, £500 net; for February, 1891, £1,150 gross, £520 net; for March, 1891, £1,210 gross, £520 net; for April, 1891, £1,250 gross, £540 net; estimated returns for May and June (the end of the financial year), based on the April returns, £2,500 gross, £1,080 net. Total £16,258 gross; total, £6,655 net. The proportion of working expenses to gross earnings has been abnormally large during this period, owing to the fact that the works, during the whole of the year 1890 and up to the present time, have been under reconstruction and rearrangement. It will be seen that after providing for the debenture interest, which amounts to £3,500 per annum, and for the administration expenses in England, there will remain a considerable balance for dividend on shares. The subscribers during the period above referred to have increased from 1,511 in April, 1890, to 2,092 in April, 1891 (namely, 1,721 connected up and 371 in course of being connected). It is contemplated to increase the rental for the telephones, and as subways for underground wires have now been laid on a portion of the company's system, there is every expectation of a considerable reduction in the working expenses in the future, which together with the growing increase in the gross earnings should add considerably to the profits in the current year which commenced on the 1st inst.

The Globe Telegraph and Trust.

THE directors have issued the balance sheet and accounts for the year ending July 18th, 1891. The net revenue for the year, after deduction of expenses, amounts to £201,698 12s. 1d., which, with the balance of £118 18s. 6d. brought forward, make a total of £201,817 10s. 7d. From this amount there has been distributed the sum of £133,059 5s. 3d. in interim dividends, leaving an available balance of £68,758 5s. 4d. The directors recommend the payment of a final dividend for the year of 3s. per share on the preference shares, and of 4s. 6d. per share on the ordinary shares, making, with the former distributions, a total dividend for the year of 6 per cent., less income tax, upon the preference, and 5¼ per cent. net upon the ordinary shares (against 5 per cent. for the preceding year), and carrying forward a balance of £1,876 15s. 9d. The Imperial German Government have, in virtue of their agreement entered into with the German-Norwegian Telegraph Company, taken over that company, and will pay off the capital at par. This company held virtually the whole of the capital, which is now being paid off. 95 per cent. of the amount has already been encashed, less exchange, and the balance, in accordance with German law, will be payable in the early part of next year. The sum repaid has been £66,956. The directors have re-invested this capital in the following securities:—1,850 shares in the Western Union Telegraph Company, costing £31,482 18s. 1d.; 2,050 shares in the American Cable Company, costing £35,337 11s. 2d. There remains a small balance still to re-invest.

Anglo-American Telegraph Company, Limited.—At a meeting of the board of directors of this company, held on Friday, it was resolved to declare an interim dividend for the quarter ending June 30th, 1891, of 12s. per cent. on the ordinary stock and £1 4s. per cent. on the preferred stock, less income tax, payable on August 1st to the stockholders registered on the books of the company on July 14th, 1891.

Direct Spanish Telegraph Company, Limited.—On 20th inst. this company opened a branch telegraph office at Winchester House, Old Broad Street, E.C.

Spanish National Submarine Telegraph Company.—An interim dividend of 2s. per share has been declared by the board.

TRAFFIC RECEIPTS.

The City and South London Railway Company. Traffic receipts for the week, ended 19th July, £689; aggregate for the half-year to date, £1,890.

The West India and Panama Telegraph Company. The receipts for the two weeks ended July 15th show a decrease of £877 as compared with the corresponding month of last year.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (July 16).	Closing Quotation. (July 23.)	Business done during week ending July 23, 1891. Highest.	Lowest
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	98 —101 xd	98 —101	...	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	45½— 46½	44½— 45½	44½	...
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	84 — 85	83½— 84½	84⅝	83⅝
2,809,310*l*	Do. do. Deferred	Stock	10½— 11	9⅝— 10¼	...	...
130,000	Brazilian Submarine Telegraph, Limited	10	11½— 12	11⅜— 12¼	12	11¼
84,500*l*	Do. do. 5 p. c. Bonds	100	101 —104	101 —104	103½	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	105	...
63,416	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	2⅜— 2⅝	2⅜— 2⅝	2⅝	2 7/16
63,416	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	1⅞— 2	1⅞— 2	1⅞	1⅞
50,000	City and South London Railway, Nos. 1 to 50,000	10	4 — 5	4 — 5	...	...
$7,216,000	Commercial Cable, Capital Stock	$100	103 —107	103 —107	...	...
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	7/16— 9/16	7/16— 9/16	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	4 — 5	4 — 5	...	...
16,000	Cuba Telegraph, Limited	10	10½— 11½	10½— 11½	...	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18	17 — 18	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 4	3½— 4	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10½— 10⅝	10½— 10⅝	10⅝	10 11/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅞— 15	14⅞— 15⅛	15 1/16	14⅞
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15⅜	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	107 —110	107 — 110	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	106 —109	108½	107
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14⅞— 15⅛xd	14⅞—15⅛ xd	15⅛	14⅞
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	101 —104	101 —104	...	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	101 —104	101 —104	..	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	105 —108	105 —108	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	101 – 104	101 —104	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	101 —104	101 —104	101⅜	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101	99 —101	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	3 — 4	2½— 3½	3¼	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	2½— 2⅝	2⅝— 2⅝	2⅞	2¼
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3½— 4	3½— 3⅝	3 11/16	3 3/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1¼— 1⅜	1¼— 1⅜	1⅜	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	...
180,227	Globe Telegraph and Trust, Limited	10	9⅝— 9⅞	9⅝— 9⅞	9⅞	9⅝
180,042	Do. do. 6 p. c. Preference	10	15 — 15½	15 — 15¼	1 3/16	14⅝
150,000	Great Northern Tel. Company of Copenhagen	10	18¼—18⅝	18¼—18⅝	18⅝	...
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108	105 —108	...	...
9,334*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	8 — 8½	8 — 8½	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	10 — 11 xd	10 — 11	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½xd	18½— 19½ xd	19½	19
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	39 — 41	39 — 41	40	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	7½— 8½	7½— 8½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9½— 9¾	9½— 9⅝	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6½— 7½	6½— 7⅛	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	106 —109	106 —109	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	9⅜— 10½	9⅜— 10½	...	...
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜— 5 xd	4⅜— 4⅞ xd	4 15/16	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	13 — 13½xd	12½— 13½ xd	...	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	12½— 13 xd	12½— 13 xd	12 11/16	...
350,000	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	105 —107	105 —107	106½	105½
6,318*l*	Notting Hill Electric Lighting Company, Limited, £8 paid ..	10	3½— 4½	3½— 4½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16— 5/16	3/16— 5/16	...	...
9,000	Reuter's Limited	8	8 — 8½	8 — 8¼	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	6⅜— 7¼xd	6⅜— 7¼xd	7⅛	6⅞
7,900	Do. do. do. 7 per cent. pref.	2	3¼— 3⅜xd	3¼— 3⅜xd	3 11/16	3¼
3,381	Submarine Cables Trust	Cert.	115 —120	115 —120	116½	115½
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4⅝	4⅜
37,350	Telegraph Construction and Maintenance, Limited	12	44 — 46 xd	44 — 46 xd	45½	45
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	101 —104	101 —104	103	...
58,000	United River Plate Telephone, Limited	5	2½— 3½	2 — 3	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9 xd	8 — 9 xd	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	95 — 98	96 — 99	97	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	97 —102	97 —102	100	...
64,174	Western and Brazilian Telegraph, Limited	15	11 — 11½	11 — 11½	11⅜	11
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6½— 7	...	...
27,873	Do. do. do. 5 p. c. Deferred	7½	4⅜— 4⅝	4¼— 4⅜	4 11/16	4⅜
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	104 —107	104 —107	...	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	105½	...
88,321	West India and Panama Telegraph, Limited	10	2⅛— 2⅜	2 — 2⅛	2 5/16	2⅛
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	10 — 10½	10 — 10½	10⅜	10⅜
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	9 — 10	9 — 10	...	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	117 —122	117 —122	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	100 —104	101 —105	104½	...
42,853	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	4⅜— 5⅛	4⅜—5⅛	...	...

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7¼—7⅜.—City of London Electric Lighting (Pioneer), Shares of £50, fully paid, 60—62.—Elmore's Austrian Copper Depositing, 15s., 25s.—Elmore's Priorities, 3⅞—4¼.—House to House Company (£5 paid) 4⅜—5¼.—Liverpool Electric Supply, £3 paid, 2⅝—2⅞.—London Electric Supply Corporation, Ordinary (£5 paid), 1⅜—2.—Manchester, Edison and Swan Company, £9 (£1 paid) 2s 6d.—5s.—National Telephone Debentures, 2½—3 prem.—Woodhouse and Rawson Ordinary of £5 (£2 10s. paid), 2½—2⅝.—£5 Preference, fully paid 3⅞—4¼.—Debentures 90—95.—Wards Electric Car, £10 paid, ¾—1.

BANK RATE OF DISCOUNT —2½ per cent. (2nd July, 1891).

THE UTILISATION OF THE POWER OF NIAGARA FALLS, AND NOTES ON ENGINEERING.*

THE falls of Niagara, always regarded as a wonderful work of nature, have more recently been looked upon as a possible source of water-power beyond anything that at present we know of. Niagara itself seems to be so situated in respect to the population of the United States as to be a place to which manufacturers might naturally go. The railway facilities are abundant, labour is cheap in the surrounding neighbourhood, it is on the line of water communication from the great Lakes, and also, what is of the greatest importance, near to the largest markets.

The drainage area supplying the falls is enormous, amounting to more than twice the area of the United Kingdom of Great Britain and Ireland. The length of shore line of lakes and rivers is about 5,000 miles.

There is a fall of 326 feet between the water level of Lake Erie and Lake Ontario, which mostly occurs in the vicinity of the falls. The average discharge of water from Lake Erie into the Niagara River is estimated at 265,000 cubic feet per second, while the extreme limits of variation in the depth of the river above the falls is $3\frac{1}{2}$ feet, so that practically the flow of water is invariable and unlimited.

On the proposition of Mr. Evershed, one of the surveyors of New York State, who proposed developing the power of Niagara Falls, several gentlemen busied themselves with the subject, and asked Mr. Sellars to report upon the cost of transmitting power by electricity as compared with the cost of generating power by steam at any given location. Having carefully examined Mr. Evershed's scheme, it was found to be feasible, and that if 20,000 horse-power could be let out at rental out of the total 120,000 horse-power that was talked of being used, a reasonable rental would pay interest on the investment expended in plant and purchase of land. A company was therefore formed with Mr. Adams, a New York banker, as president. Accompanied by Mr. Adams, Mr. Sellars visited Europe to examine various methods employed there in transmitting power to a distance. But as the main thing was to find out the best means of transmitting power of Niagara Falls to Buffalo, &c., and to get at a knowledge of the exact state of the art of developing water-power as well as transmitting the power, it was proposed to interest Sir William Thomson and make him president of a commission, to consider plans to be submitted by selected engineers.

Although Sir William Thomson's statement, some years ago, that New York and other distant cities would be lighted from the Falls of Niagara, has not yet been fulfilled, still substantial progress has been made in the art of transmitting power by electricity, and advance is being made every day.

It was somewhat difficult to find men to act upon a commission with Sir William Thomson to consider the subject, because the majority of those who were noted for their scientific pursuits were already retained by one or the other of the various electrical companies or companies for the transmission of power, and *it was not very easy to get any who were free and could act without bias in a commission of this character*.

Finally, Col. Th. Turrettini, the mayor of Geneva, was selected as the representative of Switzerland, because he was a noted hydraulic engineer, who had made all the improvements on the river Rhône at Geneva, whereby the individually-owned water-wheels were swept away, and the power of the river was transferred to all parts of the city by pipes conveying water from one central station, the water first being pumped into reservoirs on the surrounding hills, and brought down to the town at two different pressures to suit requirements. Col. Turrettini adopted the hydraulic method, because the Swiss were accustomed to hydraulics, and look upon their mountains and the streams flowing thence as their coal mines. During the past few years small streams that had previously run but a single small flax mill have been made to drive tens of thousands of spindles by the improved mode of utilising this water, and the Swiss people found that they had the means of developing a great deal of unused hydraulic power.

America, however, is in a better situation for the use of power than Switzerland, because there are more uses for the manufactures, and more markets for the goods. Col. Turrettini would not repeat the hydraulic plant which is in use in Geneva, but would, in all probability, if called on to do the work again, employ electricity. The much-lauded rope transmission is being given up throughout the country for electrical transmission, which is said to be paying its way.

A paper mill near Grenoble, in France, was operated by steam. It did not pay, so it was proposed to take water-power from the mountains, about five miles off. In the winter it is impossible to reach these mountains, where the wheels are placed, and communication can only be held by telegraph or telephone. For nearly two years this paper mill has been worked by a continuous current plant, at an estimated efficiency of 55 per cent. They are now about to duplicate their machinery, and rent power at the reputed profitable rate of about £4 per horse-power per annum.

The commission was eventually composed of Sir William Thomson, president; Coleman Sellars, Professor of Mechanics at the Franklin Institute, as representing the company and the United States; Col. Th. Turrettini, for Switzerland; and Prof. E. Mascart, of Paris, to represent France; with Prof. W. C. Unwin as secretary. By the kind permission of the directors of the Central Institute of the Guilds of the City of London, the headquarters of the commission was established in a room at the Central Institution building at South Kensington, where many conferences were held and correspondence conducted. At the early meetings of the commission the persons were selected whose advice was deemed of great value, and these engineering firms and individuals were asked to submit plans:—

1. Of the generation of the power by turbines or other water motors.

2. For the transmission of the power so generated to the factories on the land of the company, and then to an area within a two-mile radius from the central station. After that to Buffalo and Tonawanda, or to an area contained in a circle within a radius of 20 miles.

Substantial prizes were offered, besides which, all who sent in plans and estimates in accordance with the specifications were to be paid a sum of money to compensate in some degree for the labour expended. The plans and estimates came in on the last day of 1890, but were not considered until about a month later. The session of the commission lasted one week, and was conducted with great care and dignity, mainly in French.

Some of the estimates submitted were remarkable, illustrated by costly drawings, and accompanied by volumes of valuable information. The whole of the plans were so duplicated that each member of the commission had a set of drawings, specifications, estimates, and of the written explanations for his sole use.

All these schemes were based on what the company had already begun. A tunnel requiring about 490 square feet of rock excavation is being driven from above Port Dey, where the existing hydraulic canal takes its water, on the land of the company under the town of Niagara to a few feet below the Upper Suspension Bridge, a total length of 6,700 feet, to be extended up stream farther, as required, when the mill sites may be occupied. Only the lower end of the surface canal, as designed to feed the wheels that are to discharge into the tunnel, will be at present built.

It has been asked why use a tunnel for a tail race and place the mill sites above the falls, when a more natural plan would be a duplication of that existing. The chief reasons why it cannot be done there is that is no land at a reasonable price available, and that public opinion is against manufactories being built on the edge of a stream so as to spoil the beauties of the cataract. The advantages of a tubular tail race is that the water can be discharged at a much higher velocity than by a canal, in the proportion of 8 to 1, and does not interfere with the surface of the land.

The plan proposed by Mr. Evershed contemplated a number of surface canals entering the lands of the company, at right angles to the river, and passing from the tunnel, which was to extend under the new town. This plan was changed to one canal with lateral branches.

There will be a central station for the generation, first of about 5,000 horse-power by compressed air, another one of

* Abstract of paper read before the Franklin Institute on May 20th, 1891, by Coleman Sellars, E.D.

5,000 horse-power by electricity, with a possible extension of either of these to the amount of 100,000 horse-power, added by degrees to either, in whichever direction proves the most profitable and is called for by manufacturers. The company intend to proceed with caution and to avoid mistakes, and have placed the matter in the hands of a board of engineers consisting of Mr. Sellars as chairman, Col. Turrettini as foreign consulting engineer, and several other engineers.

Should the Niagara Power Company find customers for 120,000 horse-power, the depth of water passing over the falls will not, it is calculated, be affected more than a single inch, not sufficient to make any perceptible difference in the appearance of the falls. 120,000 horse-power would furnish power to drive machinery capable of finding employment for 250,000 men; that is to say, about two men to one horse-power. The Baldwin Locomotive Works employ 5,000 men and utilise 2,500 horse-power; William Sellars & Co. 600 men and about 300 horse-power; the latter firm manufacture shafting, and have learned during their long experience that seldom more than 50 per cent. of the power transmitted by shafting reaches the machines, and this efficiency decreases the farther the power has to be transmitted.

Wire rope transmission is more economical than shafting, but all these methods are being replaced by electrical means. It is estimated in Switzerland that power may be transmitted 15 miles at a cost of less than £12 per horse-power for actual cost of machinery, &c. There are some men in England who believe that it can be done cheaper than that.

Mr. Sellars says he was much gratified by what he saw in Europe. He was interested in the Deptford installation, and calls Mr. Ferranti a very venturesome mechanic, and thinks that the 10,000 horse-power unit may be suitable for a gigantic city like London, where light is often wanted by day as well as by night. Being invited to see a repetition of the experiment wherein a man drives a chisel through the concentric cable, with 10,000 volts alternating being transmitted, without suffering personal damage, the offer was declined on the ground that it was known to be perfectly safe, if the chisel strikes both the outer and inner copper conductors; but if a small portion of the outside copper casing be cut away, and then an attempt be made to cut the inner copper, the operator would be instantly killed.

Mr. Brown, of Oerlikon, by means of oil transformers has experimented on the transmission of electricity at 30,000 volts, and is bringing to Oerlikon the power of a waterfall a number of miles, and intending to drive the whole of the machinery there by electricity.

At Rome they are about to bring electrical power from Tivoli by naked conductors at 5,000 volts, to be lowered to 2,000 volts before entering the city by underground concentric cables, and then lowered by other transformers to enter the houses.

Ganz & Co., one of the firms which submitted plans to the Niagara International Commission, erected the present plant at Rome, using the alternating current and the three-wire system; arc and incandescent lamps are operated conjointly by the same three wires.

The alternating current seems to come to the fore on account of the ease with which it can be transmitted a long distance by slender cables, and the voltage can be varied at pleasure.

Mr. Sellars accompanied Prof. George Forbes to see the Mordey alternator at work in London, where they operated a generator as a motor, giving it work to do to the extent of 50 per cent. more than its calculated capacity, without its showing the least fatigue, and after half a day's work not even being warm. There was no trouble with it; the speed was constant whether load was taken off or put on; for when the driving power is constant and uniform in its speed, the motor driven by it is in perfect step.

Speaking of Prof. G. Forbes, Mr. Sellars remarks that he was much impressed by his bold stand in favour of the alternating current, and his command of the subject as an educated engineer, in presenting his plan of utilising the power of Niagara; and looking back to the meeting in London, and his opportunity to meet men noted in scientific engineering, some among them seem to tower mentally over others, and one can readily feel that such men are masters.

In Rome, where they first demonstrated practically the running of alternators in parallel, coupled electrically only, Dr. Mengarini has adopted 600 H.P. as a unit plant for steam driving, and 350 H.P. for the unit when driven by water at Tivoli. On the very stones placed by Cæsar stands the foundation of the engines that now furnish light by gas and electricity to the city of Rome.

The development of compressed air at Niagara merits consideration, since a good authority states that 50,000 H.P. can be carried 20 miles through two pipes 26 inches in diameter, and it will enable existing factories to utilise their present engines; at all events until such time as electricity is more universal. Mr. J. Pearsall, an Englishman, who presented plans to the Commission, he says that the best way to generate the power by compressed air is to do it by hydraulic ram, wherein in place of the valve closed with a slam by the current, he has introduced a set of valves driven by a separate power.

One thing observable in Europe was the almost universal use of the slide rule for calculations, and Mr. Coleman Sellars advises all young electrical engineers to obtain a mastery over the use of the instrument.

THE INTRODUCTION OF THE ELECTRIC LIGHT AT AGRAM.

[FROM OUR OWN CORRESPONDENT.]

THE city of Agram, the capital of the Hungarian "Crownland," Croatia, has resolved on the introduction of the electric light, and to this end it has concluded an agreement with a Mr. E. F. Bothe, a merchant of the city, according to which the latter obtains the concession for laying down leads for conveying and supplying electric current. The essential conditions of this agreement, which are very interesting in several respects, are as follows:—

Paragraphs 1 and 2 give the grantee, for a term of 50 years, the right to use public territories for laying down leads. Up to July 1st, 1900, this right is exclusive, but after this date concessions may be granted to other applicants; but in this case Herr Bothe, as against other applicants, will have the position of the "most favoured" party. If during the first 10 years of the concession a new means of lighting (not involving the use of electricity) should be invented, the exclusive claim expires as against this new non-electric system.

According to section 3 after the expiry of the 50 years all the leads laid down in public ground pass gratis into the possession of the city, which has also the right to purchase at a valuation all other portions of the electric works, buildings, machinery, &c.

The municipality has the right (according to sections 4, 5, and 6) on renouncing the right secured in section 3, after the expiry of the first 30 years of the agreement to acquire the entire electrical works at 15 per cent. below the valuation price. Notice of the intention so to do must be given in writing at latest in the year before.

In case the city does not demand the right secured to it by section 3 within the 49th year of the agreement, the concession, in accordance with section 7, remains in force for 25 years longer. After the expiry of such further term of 25 years, not only the leads, as mentioned in section 3, but all other portions of the electric works, movables, as well as fixtures, pass gratis into the possession of the city. The grantee is therefore not entitled to encumber the works or any portion thereof with mortgage debts.

If the city purposes leasing the electric works which have thus passed into its possession, the present grantee, or his legal successor, has, according to section 8, the right of refusal as against any third party, the conditions being equal.

For the use of the public territories the grantee has to pay a yearly ground tax of 1 kreutzer per metre run of the main lead (section 11).

According to section 13 the grantee is bound to begin the erection of the works as soon as a daily consumption of 60,000 watts (watt hours) is guaranteed. He is also bound to secure this minimum consumption within three months after the signature of the agreement; to make known this fact to the authorities and then to commence the supply within a year.

If the grantee has not secured a consumption of 60,000 watts within the three months aforesaid, and thus cannot commence the supply, his deposit will be returned to him

and the agreement will be considered as cancelled. If, however, the grantee, although this consumption is secured does not begin at the proper time, the municipality has the right to annul the agreement by a simple letter to him and to retain the security which has been deposited. In this case the grantee will be summoned to remove within six months all leads which may have been laid down and any plant which has been erected. In default these appliances pass gratis into the possession of the city.

As security for executing the duties which he has undertaken, the grantee must deposit the sum of 2,000 florins. But if the leads extend to more than 5,000 metres run the deposit must be increased by 100 florins for every additional kilometre.

If the grantee after the supply has been commenced finds himself compelled on valid grounds to interrupt the service and does not renew it within a month after formal demand, the city is entitled to confiscate the deposit, and as far as the electric works and the leads are concerned to put in force the provisions of section 13, or, at pleasure, those of sections 3, 5 or 7.

Section 17 binds the grantee, in the streets fitted with leads, to supply every occupant, on demand, with electric energy under the conditions laid down in the agreement, but only in proportion to the productive capacity of the works. (By oversight no compulsory minimum for such capacity has been laid down in the agreement.)

The grantee is also bound, in streets where no main leads exist, to lay down such and to supply current, if per metre run of lead, measured from the nearest transformer or accumulator station, a consumption of 50 watts per working hour is ascertained. The duty of supplying current expires, however, in case of *vis major* (*i.e.*, foreign invasion, insurrection, conflagration, &c.).

In the absence of especial arrangements the current consumed will be reckoned according to the scale of prices laid down in the agreement, the quantity being determined by electricity meters (section 23) which the consumer may buy from the grantee. The latter is entitled to execute any requisite repairs at the charge of the consumer, and to receive such costs immediately after the completion of the work. The repair of meters supplied on hire to consumers is borne by the grantee in case the damage is not due to the fault of the consumer. The grantee alone can decide concerning the construction, size, position, and manner of setting up the meters.

Section 24 entitles the grantee to the following dues for meters supplied on hire: For meters up to 800 watts 10 florins; 1,250 watts, 16 florins; 2,500 watts, 20 florins; 5,000 watts, 25 florins yearly.

The scale of prices for the electric energy supplied is based on the unit of 100 watts. The payment for the energy consumed is, in the first place, a yearly tax of 12 florins for each 100 watts which the total of lamps installed in the premises of the consumer use when working simultaneously; this tax is paid yearly. In addition the consumer has to pay a price of 6 kreutzers per 100 watt-hours as ascertained by the electricity meter. (Rather complicated!)

The grantee is further bound, at the demand of the consumer, to undertake:—

(1.) The *maintenance* (*i.e.*, the replacement of all broken or damaged glasses and all contingent repairs, &c.,) of the *arc lamps*, if such have not been damaged by elemental events or by mischief, for a yearly sum of 20 florins.

(2.) The attendance on arc lamps at 4 kreutzers per hour of burning of each lamp.

(3.) The replacement of the carbons in arc lamps for 4 kreutzers per lamp and per hour.

(4.) The attendance on and replacement of glow lamps for a payment of 0·2 kreutzer per lamp and per hour of burning.

Section 33 establishes the advantages which must be conceded to the town itself for the supply of electricity.

The town does not pay a fundamental tax, and receives a discount of 25 per cent. off the price of 6 kreutzers per 100 watt-hours if it guarantees to the granter an average yearly consumption of 15,000 watts per lamp (this is, of course, watt-hours, but the agreement throughout mentions only "watts," without reference to time. Remarkably enough, it is not stated in the agreement to what kind of lamps, glow lights or arc lights, the condition refers, nor what is to be their minimum consumption). In case the stipulated minimum consumption is not maintained, the discount is to be only 15 per cent. instead of 25 per cent. The discount is calculated after the hire of the electricity meters has been deducted, as well as the charges specified in section 25, 1 to 4, for maintaining and attending to the lamps.

In accordance with section 34, the city of Agram enjoys the discount agreed on in section 33 for the lighting of municipal houses and buildings; but the city has to pay for this consumption the fundamental tax according to section 25, if the minimum consumption agreed on under section 33 is not reached.

REVIEWS.

Nature Series. Popular Lectures and Addresses. By Sir WILLIAM THOMSON, F.R.S., &c. Vol. I. Constitution of Matter. Second edition, with additions and corrections. London: Macmillan & Co.

The additions to the original edition of this volume consist of an appendix to the article on "Capillary Attraction;" this appendix being a recently published paper by Lord Rayleigh, describing measurements of the amounts of oil necessary in order to check the motions of camphor upon water; and also an appendix to the article entitled "Steps Towards a Kinetic Theory of Matter." The general contents of the volume are as follows:—"Capillary Attraction," with four appendices; "Electrical Units of Measurement;" "The Sorting Demon of Maxwell;" "Elasticity Viewed as Possibly a Mode of Motion;" "The Size of Atoms;" "Steps towards a Kinetic Theory of Matter;" "The Six Gateways of Knowledge;" "The Wave Theory of Light;" "On the Age of the Sun's Heat;" "On the Sun's Heat;" "Electrical Measurement;" appendix to "Steps towards a Kinetic Theory of Matter."

Nature Series. Popular Lectures and Addresses. By Sir WILLIAM THOMSON, F.R.S., &c. Vol. III. Navigational Affairs. London: Macmillan & Co.

In the preface to Vol. I. the author states that Vol. II. of the series will not appear for a year or two, the subject to be dealt with being connected with geology. In the present volume the subjects are:—"Navigation;" "The Tides;" "Terrestrial Magnetism and the Mariner's Compass;" "On Deep-Sea Sounding by Pianoforte Wire;" "On Lighthouse Characteristics;" "On the Forces Concerned in the Laying and Lifting of Deep-Sea Cables;" "On Ship Waves." An interesting appendix, by Captain Creak, describes a "Remarkable Local Magnetic Disturbance near Cossack, North-West Australia;" in this case, at a particular position, the north point of the compass was suddenly deflected two points to the westward. The centre of this disturbance was found to be about 50 feet in diameter, and the whole area covered a space of one square mile. The cause of the phenomenon remains unexplained.

Telephones: their Construction and Fitting. A practical Treatise on the Fitting up and Maintenance of Telephones and the Auxiliary Apparatus. By F. C. ALLSOP. London: E. and F. N. Spon.

The greater part of this work was originally published in the pages of the *English Mechanic*. Like all Mr. Allsop's works the present one is thoroughly practical, indeed is one of the best books on the telephone published. In speaking of and describing the Gower-Bell telephone we notice that the writer states that "its having an exposed diaphragm is an objection;" as a matter of fact the whole of the Gower instruments employed by the Post Office have a covered over diaphragm with a mouthpiece so that the former is not exposed; the description of this instrument might with advantage have been made lengthier, it is actually discussed in a page and a half.

On page 115 the writer has got a little mixed in describing insulators; what he calls and describes as a Z insu-

lator is really a Cordeaux screw, and not the Z-pattern at all. In Chapter IV., dealing with complete instruments, the dates of the expiry of the various master telephone patents are given; it is stated with reference to the claim for the Crossley instrument that this is defined as a compound microphone having 3, 4, or more pencils, with 6, 8, or more points of contact as differing from the "ordinary," or simple microphone having only one pencil and two points of contact as in the Hughes. Now, as a matter of fact Hughes in his classical paper states that the effects may be increased by "multiplication of transmitting contacts in quantity or intensity," so it is somewhat surprising that such a claim could have been made.

Patents for Inventions, and How to Procure Them. By G. G. M. HARDINGHAM. London: Crosby Lockwood & Son.

This is a small work of between 40 and 50 pages and it contains practically all the information patentees require in order that they may be able to fully protect their inventions. All points in connection with the taking out of patents, such as may seem to need explanation are clearly explained. The book is undoubtedly a useful one, the more so from its not being unnecessarily diffuse.

RECENT APPLICATIONS FOR PROVISIONAL ELECTRIC LIGHTING ORDERS.

THE Board of Trade last week issued a report as to the applications to and proceedings of that body under the Electric Lighting Acts 1882 to 1890. From this report we find that the following applications for provisional orders have been received by the Board since the date of the last report (the promoters' names being placed in parentheses):—

LONDON.—Camberwell: Camberwell and Islington Electric Light and Power Supply (Camberwell) Electric Lighting Order. A portion of the parish of St. Giles, Camberwell (Camberwell and Islington Electric Light and Power Supply, Limited). City of London Electric Lighting (Brush) Order. A portion of the City of London (Brush Electrical Engineering Company, Limited). East London Electric Supply Order. The district of Whitechapel, Hackney, and the parish of St. Leonard, Shoreditch (Laing, Wharton and Down Construction Syndicate, Limited). Hampstead: Stamford Hill, Tottenham, and Edmonton Electric Light and Power Supply (Hampstead) Electric Lighting Order. The parish of Hampstead (Stamford Hill, Tottenham, and Edmonton Electric Light and Power Supply, Limited). Islington: Camberwell and Islington Electric Light and Power Supply (Islington) Electric Lighting Order. The parish of St. Mary, Islington (Camberwell and Islington Electric Light and Power Supply, Limited). New Cadogan and Belgrave Electric Supply Company Electric Lighting Order. Portions of the parishes of St. Luke, Chelsea, and St. George, Hanover Square (New Cadogan and Belgrave Electric Supply Company, Limited), North London Electric Lighting (Brush) Order. The parishes of St. James and St. John, Clerkenwell, St. Luke, Middlesex, and St. Leonard, Shoreditch (Brush Electrical Engineering Company, Limited). Paddington and Bayswater Electric Light and Power Supply (Paddington) Electric Lighting Order. Parish of Paddington (Paddington and Bayswater Electric Light and Power Supply, Limited). Southwark Electric Lighting (Brush) Order. District of the St. Saviour's District Board of Works (Brush Electrical Engineering Company, Limited). Wandsworth district; Stamford Hill, Tottenham, and Edmonton Electric Light and Power Supply (Wandsworth district) Electric Lighting Order. District of the Wandsworth District Board of Works (Stamford Hill, Tottenham, and Edmonton Electric Light and Power Supply, Limited). Westminster Electric Lighting Order. Portion of the united parishes of St. Margaret and St. John, Westminster (Westminster Electric Supply Corporation). Woolwich Electric Lighting Order. A portion of the parish of Woolwich (Woolwich District Electric Light Company, Limited).

PROVINCIAL, WELSH, SCOTCH, AND IRISH.—Aberystwith: Provincial Electric Light and Supply (Aberystwith) Electric Lighting Order. The borough of Aberystwith (Provincial Electric Light and Power Supply, Limited). Acton Electric Lighting Order. The Urban Sanitary District of Acton (the Local Board). Birmingham Electric Light and Power Order. A portion of the city of Birmingham (Birmingham Electric Supply Company, Limited). Bishops Stortford Electric Lighting Order. The parish of Bishops Stortford (Bishops Stortford Electric Light and Steam Laundry Company, Limited). Bolton Electric Lighting Order. The municipal county borough of Bolton (the Corporation). Brighton Electric Supply Order. A portion of the municipal borough of Brighton and the parish of Preston (Brighton and Hove Electric Light Company, Limited). Bromley (Kent) Electric Lighting Order. The Urban Sanitary District of Bromley (the local Board). Canterbury Electric Lighting Order. The city of Canterbury (the Corporation). Cardiff Electric Lighting Order. The county and municipal borough of Cardiff (the Corporation). Chiswick Electric Lighting Order. The parish and district of Chiswick (the Local Board). Coventry Electric Lighting Order. The city of Coventry (the Corporation). Croydon Corporation Electric Lighting Order. The county borough of Croydon (the Corporation). Dewsbury Electric Lighting Order. The municipal borough of Dewsbury (the Corporation). Ealing Electric Lighting Order. The Local Government District of Ealing (the Local Board). Edinburgh Corporation Electric Lighting Order. The city and royal burgh of Edinburgh (the Corporation). Exeter Electric Lighting Order. The city and county of the city of Exeter (the Corporation). Exeter Electric Lighting Order. The city and county of the city of Exeter (Exeter Electric Light Company, Limited). Hanley Electric Lighting Order. The municipal borough of Hanley (the Corporation). Harrogate Electric Lighting Order. The municipal borough of Harrogate (the Corporation). Heckmondwike Electric Lighting Order. The urban sanitary district of Heckmondwike (the Local Board). Hertford Electric Lighting Order. The municipal borough of Hertford, together with portions of the parishes of Bengeo, Hertingfordbury, St. Andrew and St. John, and the liberties of Brickendon and Little Amwell (the Corporation). Ipswich Electric Lighting Order. The Parliamentary borough of Ipswich (the Ipswich Electricity Supply Company, Limited). Ipswich Electric Lighting Order. The borough of Ipswich (Laurence Scott and Company, Limited). Kidderminster Electric Lighting Order. The municipal borough of Kidderminster (the Corporation). Killarney Electric Lighting Order. The township of Killarney (the Town Commission of Killarney). Killarney Electric Lighting Order. The urban sanitary district of Killarney (C. E. Leahy, Esq.). Kingston-upon-Thames Electric Lighting Order. The borough of Kingston-upon-Thames (the Corporation). Leamington Electric Lighting Order. The municipal borough of Royal Leamington Spa (the Corporation). Leamington: Royal Leamington Spa Electric Light and Power Order. A portion of the borough of Royal Leamington Spa (Midland Electric Light and Power Company, Limited). Leeds Electric Lighting Order. A portion of the municipal borough of Leeds (Electric Installation and Maintenance Company, Limited). Leeds Electric Lighting Order. A portion of the parish of Leeds (National Electric Supply Company, Limited). Leeds Electric Supply Order. The municipal borough of Leeds (Yorkshire House-to-House Electricity Company, Limited). Liverpool Electric Lighting Order. A portion of the city of Liverpool (Liverpool Electric Supply Company, Limited). Llanelly Electric Lighting Order. The borough of Llanelly (the Local Board). Londonderry Electric Lighting Order. The city of Londonderry (Corporation). Newcastle and District Electric Lighting Company's Order. The city of Newcastle-upon-Tyne (Newcastle and District Electric Lighting Company, Limited). Newport (Mon.) Electric Lighting Order. The municipal borough of Newport (Mon.) (Corporation). Norwich Electric Lighting Order. The city and county of the city of Norwich (Norwich Electricity Company, Limited). Paisley Electric Lighting Order. The municipal burgh of Paisley (Corporation). Poole Electric Lighting Order. A portion of the district of the Poole Union (Brush Electrical Engineering Company, Limited). Preston Electric Lighting Order. The municipal borough of Preston (National Electric Supply Company, Limited). Scarborough Corporation Electric Lighting Order. The municipal borough of Scarborough (Corporation). Southend Electric Lighting Order. The urban sanitary district of Southend (the Local Board). Southport Electric Lighting Order. The municipal borough of Southport (Corporation). South Shields Electric Lighting Order. The county borough of South Shields (the Corporation). Stockport Electric Lighting Order. The county borough of Stockport (the Corporation). Sunderland Electric Lighting Order. The county and municipal borough of Sunderland (the Corporation). Surbiton Electric Lighting Order. The district of the Surbiton Improvement Commissioners (Surbiton Improvement Commissioners). Torquay Electric Lighting Order. The local board district of Torquay (the Local Board). Toxteth Park Electric Lighting Order. A portion of the local government district of Toxteth Park (Liverpool Electric Supply Company, Limited). Tunbridge Wells Electric Lighting Order. The borough of Tunbridge Wells (the Corporation). Tynemouth Corporation Electric Lighting Order. The municipal borough of Tynemouth (the Corporation). Weston-super-Mare Electric Lighting Order. The urban sanitary district of Weston-super-Mare (Weston-super-Mare Improvement Commissioners). Weybridge Electric Supply Order. The parish of Weybridge (Laing, Wharton and Down Construction Syndicate, Limited). Weymouth Electric Lighting Order. The borough of Weymouth and Melcombe Regis, and a portion of the district of the Weymouth Union rural sanitary authority known as the Westham district (Weymouth Electricity Supply Company, Limited). Whitby Electric Lighting Order. The local government district of Whitby (the Local Board). Whitehaven Electric Lighting Order. The town and harbour of Whitehaven (the trustees of the town and harbour of Whitehaven). Withington District Electric Supply Order. The local board district of Withington, including Didsbury and Chorlton-cum-Hardy (Manchester House-to-House Electricity Company, Limited).

Of these applications (70 in number), 37 were made by local authorities and 33 by companies or individuals; 12 related to London. The orders granted to companies (continues the report) have, with one exception, been granted with the consent of the local authority of the district. In the case of the order granted to the New Cadogan and Belgrave Electric Supply Company, Limited, in respect of a portion of the parish of St. Luke, Chelsea, the local authority consented to the grant of an order to the company, but objected to certain provisions which were inserted by the Board of Trade, at the instance of the London County Council, in accordance with their usual practice in the case of orders relating to the metropolis. A special report with respect to this order has been made to Parliament

by the Board of Trade in accordance with the requirements of Section 1 of the Electric Lighting Act, 1888. In three instances applications were received from the local authority, and also from a company for the same area. In two cases the local authority withdrew their application, and consented to the grant of an order to the company applying, and the Board of Trade granted orders to the companies accordingly. In the third instance a local inquiry was held, after which the local authority withdrew their application and consented to the grant of an order to the company. The company, however, objected to a provision proposed to be inserted in the order by the Board of Trade, and did not proceed with their application. The orders granted to a great extent follow the form of the orders granted last session, but a clause has been inserted forbidding the placing of electric lines above ground without the express consent of the Board of Trade. At the request of the corporation of Edinburgh the Board of Trade inserted a provision in the Bill to confirm the Edinburgh Electric Lighting Order, authorising the corporation, with the consent of the Secretary for Scotland, to borrow money for electric lighting purposes, and to keep the accounts of the undertaking authorised by the order under the provisions of the Edinburgh Municipal and Police Acts, which regulate the other borrowing powers and accounts of the corporation, instead of under the Electric Lighting Acts. They also inserted in the Bill to confirm the Woolwich Electric Lighting Order a clause providing that the Woolwich Local Board of Health shall be the local authority for electric lighting purposes for the parish of Woolwich, in order to remove a doubt that existed as to the effect of the Electric Lighting Act, 1882.

The following statement shows briefly the manner in which the various applications have been dealt with:—

LONDON.—Camberwell, order granted; City of London, order granted; East London, the promoters failed to produce the consent of the local authorities or to satisfy the Board of Trade that it should be dispensed with, and the Board of Trade refused to grant the order; Hampstead, order refused; Islington, order granted; New Cadogan and Belgrave, order granted for a portion of the parish of St. Luke's, Chelsea; North London, two orders granted; one in respect to Clerkenwell and the other to St. Luke, Middlesex; Paddington, order refused on similar grounds to those in the case of East London; Southwark, order granted; Wandsworth, order granted for a portion of the parish of Putney, including Roehampton, together with a portion of the parish of Wandsworth; Westminster and Westminster, order granted in each instance.

PROVINCIAL, WELSH, SCOTCH AND IRISH.—Aberystwith, order refused on grounds similar to those mentioned above; orders were granted in the following four instances: Acton, Birmingham, Bishop's Stortford, Bolton; Brighton Electric Supply Order, order refused. The local authority obtained an order in 1883, and are now making preparations to supply energy in their district; orders were granted in the following instances: Bromley (Kent), Canterbury, Cardiff, Chiswick, Coventry, Croydon, Dewsbury, Ealing, and Edinburgh. In the case of Exeter, the corporation withdrew their application, and the Exeter Electric Light Company was granted an order, as were the following:—Hanley, Harrogate, Heckmondwike, Hertford, Ipswich (to both applications), and Kidderminster. The Killarney Town Commissioners withdrew their application and consented to the grant of an order to C. E. Leahy, Esq., Kingston-upon-Thames, order granted. In the dual application relating to Leamington, the Board of Trade directed a local inquiry to be held with respect to these applications, after which the corporation withdrew their application and consented to the grant of an order to the company. The company, however, objected to a provision proposed to be inserted in the order by the Board of Trade, and did not proceed with their application.

Orders were granted to each of the following:—Londonderry, Newcastle, Newport, Norwich, Paisley, Poole, Preston, Scarborough, Southend, Southport, South Shields, Stockport, Sunderland, Surbiton, Torquay, Toxteth Park, Tunbridge Wells, Tynemouth, Weston-super-Mare, and Weybridge. Weymouth was refused an order for not complying with the regulations; while Whitby, Whitehaven, and Withington each received an order.

Bills to confirm the orders granted were introduced into the House of Commons on the following dates:—Nos. 1 to 4, to confirm the orders relating to Bolton, Canterbury, Dewsbury, Henley, Harrogate, Sunderland, Ealing, Norwich, Southport, Stockport, Surbiton, Tynemouth, Bishops Stortford, Croydon, Heckmondwike, Londonderry, Southend, Weston-super-Mare, Acton, Chiswick, Coventry, Kidderminster, Llanelly, and South Shields on the 14th April. Nos. 5 to 11, to confirm the orders relating to Bromley, Preston, Scarborough, Torquay, Tunbridge Wells, Withington District, Edinburgh, Paisley, Hertford, Killarney, Kingston-upon-Thames, Liverpool, Toxteth Park, Whitehaven, Birmingham, Cardiff, Exeter, Ipswich (2), Whitby, Camberwell, Islington, Southwark, Wandsworth, Westminster, the City of London, Clerkenwell, St. Luke, Chelsea, St. Luke, Middlesex, Woolwich, Newport (Mon.), Poole, and Weybridge on the 2nd May. No. 12, to confirm the orders relating to Leeds and Newcastle-upon-Tyne on the May 13th. Bills Nos. 1 to 4 received Royal Assent on June 11th. Bills Nos. 5, 6, 7, 9, and 11 are awaiting Royal Assent. The other Bills are still before Parliament. The provisional orders granted by the Board of Trade last session and referred to in the last report were confirmed by Parliament with the exception of the Crompton Electric Lighting Order, which was withdrawn by the promoters, as stated in the report.

LICENCES.—No applications for licences have been received since the date of the last report. The licences referred to in the last report were dealt with in the manner shown in the following statement:—Crompton and Company, Limited (the borough of Chelmsford); licence granted October 28th, 1890; Mr. H. G. Massingham (certain streets within the city of Bath), licence granted December 1st, 1890.

NEW PATENTS—1891.

10,695. "An improved method of and apparatus for heating metal bars or blanks by electricity, for forging and other purposes." E. E. ANGELL. Dated June 23rd. (*Complete.*)

10,822. "A compound preparation to be used as a substitute for gutta-percha and similar products for insulating and waterproofing purposes." C. N. JACKSON. Dated June 25th.

10,843. "Improvements in apparatus for regulating electric currents." J. FERRAND. Dated June 25th.

10,860. "Improvements in means or mechanism for regulating the lighting intensity of electric lamps." R. J. SPREADBURY. Dated June 25th.

10,887. "An apparatus for lighting by electricity large numbers of gas burners simultaneously and cheaply, as compared with existing methods." J. WALKER and J. HAMPSHIRE. Dated June 26th.

11,093. "A simple device for detecting a leakage to earth, principally adapted to isolated electric light installations." W. J. SANDY and W. A. EASTER. Dated June 30th.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1890.

3,193. "Improvements in and connected with electric transformers." J. SWINBURNE. Dated February 28th. 8d. To render an installation supplied by a transformer safe from all risks either of fire or danger, the inventor earths the middle of the secondary circuit through a fine fuse or cut-out. If a current passes through this fuse or cut-out, the primary circuit is automatically disconnected from the whole system. The fuse may be a fine wire which holds the catch which locks a double pole switch in the primary circuit. 4 claims.

3,272. "Improvements in switches for controlling electric circuits, especially electric light circuits." G. E. FLETCHER. Dated March 1st. 6d. Relates to improvements in switches for controlling electric circuits, especially electric light circuits, by means of which the circuit or circuits may be made or broken at will by means of a cord or its equivalent, the switch being out of reach, the pulling of the cord or its equivalent either making or breaking the circuit by rotating the switch, which is caused to rotate by means of suitable clutch and clutching gear, but not ratchet gear. 2 claims.

3,937. "Improvements in electric flash-signalling lanterns and apparatus in connection therewith." W. S. RAWSON and C. S. SNELL. Dated March 13th. 8d. Is intended to enable a vertical sliding action of the extinguishing shutter or shutters to be produced by electrical means sufficiently rapidly for signalling purposes. The inventors employ two solenoids, so that the same core is suitable for both. One of these solenoids is wound with a few turns of thick wire, and the other with many turns of thin wire. The former is arranged so that when the light is obscured it is in circuit with the lamp, and reduces its intensity, the latter is arranged to work in shunt to the lamp, and it is this solenoid which pulls down the shutter against the action of a spring or similar device, which assists to raise the shutter when the current is broken in the lower solenoid. 5 claims.

4,791. "An improved instrument for measuring electrical currents." W. H. DOUGLAS. Dated March 27th. 8d. The inventor attaches terminals to a plate of metal, the terminals being conveniently separated from each other and connected by a strip of metal forming a bridge. The conductivity of the bridge being sufficiently small to resist the current, is heated in proportion to the strength of the current passing through. The bridge is held in tension midway by a spring or weight. The expansion in the bridge caused by the resistance to the current is thus induced to rise or dip as desired. The rise or dip is then measured by multiplying gear. The compensation for temperature is effected by attaching the terminals to the before-mentioned plate, which must be of the same coefficiency of expansion as the metal used to form the bridge. 3 claims.

4,984. "Improvements in electric telegraph apparatus to transmit visible pointer indications corresponding to the movement of a transmitting handle." J. ROBINSON. Dated March 31st. 8d. Consists mainly in the utilisation of the movement of the transmitting handle to automatically unlock the device, and to produce a mechanical tension in a spiral spring, the reaction of the said spring causing the revolution of a train of wheels and flyer, and by its motion causing an electrical contact to be formed in one of three alternative directions, according to the direction of movement of the transmitter handle, permitting the passage of a current (rendered intermittent by a commutator to a receiving instrument, consisting of three pairs of electro-magnets provided with spring armatures, the oscillating movement of which is communicated by a roller at the extremity of each armature to a star wheel operating an indicating finger by suitable gearing until the action of the spring mechanism is satisfied and locked, when the indicator coincides with the position of the transmitter handles. 6 claims.

5,008. "Improvements in electro-telephonic apparatus." E. F. FURTADO. Dated March 31st. 6d. The inventor combines a transmitter, receiver and call bell, or receiver and call bell in such a manner that the essential parts of the telephone are placed within the gong of the bell in order that the gong may act as an alarm, and also as a protecting case for the telephone; and to the board, tray box or other suitable arrangement, against which the telephone is either

hung or clamped, to effect the necessary switch arrangement, is fixed a hammer, or clapper actuated by an electro-magnet or magnets concealed in recesses formed in the back of the board or within the tray, box or other suitable arrangement. 2 claims.

5,016. "Improvements in reversible machines suited for alternating electric currents." C. P. BABY. Dated March 31st. 8d. The chief feature of the machine is its symmetry and consequent convertibility, resulting from the construction of one part constituting the field magnets equal and similar to the other part constituting the armature, these two parts being so placed on these common axis, the one fixed on the framing, and the other free to rotate with the axis, that the poles of the magnets of the one face those of the other.

5,540. "Improvements in apparatus in which electrical measures are obtained by the aid of a wire or filament heated by the passage of a current." F. H. W. HIGGINS. Dated April 11th. 8d. Claims:—1. The construction of voltmeters and other apparatus in which measures are obtained by the aid of a wire or filament heated by the passage of a current in such a manner that a vacuum or partial vacuum may be maintained around the wire or filament. 2. The construction of voltmeters and other apparatus in which measures are obtained by the aid of a wire or filament heated by the passage of a current in such a manner that the sensitiveness of the instrument may be readily regulated by adjusting the air pressure in the chamber surrounding the wire or filament.

5,750. "Improvements in armatures for dynamo-electric machines and electric motors." R. E. B. CROMPTON. (Partly communicated from abroad by W. Fritsche, of Berlin.) Dated April 16th. 8d. The improved wheel armature may be described as consisting of a central hub made of any material magnetisable or non-magnetisable, providing that it possesses sufficient strength and rigidity for the purpose. This hub, or centre, is in two parts, one of which forms its body, and the other part is a separate flange or ring, which holds the staves or spokes hereafter described firmly in their correct position. The armature winding consists of a number of soft iron strips or staves of spoke-like form. These spokes are held on their inner ends by the above described hubs, and are provided that their outer ends with abutting segments, so that when arranged in correct order and position, they form a complete wheel, with hub, spokes and periphery of great mechanical strength to resist centrifugal and tangential forces. 2 claims.

5,926. "Machine for covering electrical conductors and cables with lead." SYDNEY PITT. (A communication from abroad by J. B. Atherton, of New York.) Dated April 18th. 8d. In this improved machine the lead cylinder is arranged transversely to the hollow core bar and die, but at the rear of the die proper, where the end of the core bar and the face of the die approximate each other, and between the end of the core bar and the extension of the lead cylinder is placed a partition, which serves as a support for the end of the core bar, and has apertures through which the lead is forced into the lead chamber surrounding the end of the core bar. This partition is made removable, so that the opening in the block, which constitutes an extension of the lead cylinder, and contains the lead chamber and the core bar and die, may be entirely opened through and through. 6 claims.

6,266. "Improvements in means for use in electrolysis." J. MARX. Dated April 24th. 8d. The respective electrodes (cathodes and anodes) are placed above each other, but not as has been sometimes done in the same vertical plane, but the one above or below the other, and in a different vertical plane. The cathodes may be above and the anodes below, or an inverse arrangement may be used as may suit particular circumstances. 4 claims.

6,267. "Improvements in means for connecting electrical conductors to act as a safety device." J. MARX. Dated April 24th. 8d. The inventor places the electrodes in a box or container, so that a portion of them projects into a space in the said box or container, through which space is passed the wire or conducting strip to be connected to the electrodes, and then he fills into the said space a composition which is electrically conductive and can be moulded into the said space, and will attach itself both to the wire or strip and the electrodes. When this is cool, the box or container, which has acted as a mould, is removed, and the wires or strips and electrodes are found to be properly connected with each other. 4 claims.

6,475. "A safety device for electric circuits." W. LOWRIE and C. J. HALL. Dated April 28th. 8d. The inventors employ a pair of conductors placed within a closed vessel containing a rarefied gas. The conductors tend to come into contact, but are normally separated by a material which will become carbonised or destroyed by the electric current should the electrical pressure exceed a given limit, thus allowing the conductors to come into electrical contact with each other, and so close the circuit to earth. 5 claims.

6,495. "Improvements in electric telegraphs." A. M. CLARK. (A communication from abroad by S. Schuckert & Co., of Nuremberg.) Dated April 28th. 8d. Claims:—1. A visual telegraph characterised by the employment at the transmitter of a switch disc, divided into two parts, in combination with rubbing contacts, whereof the former are respectively connected by conductors with contacts at the transmitter, and the latter are connected with the field or armature coils of an electro-motor at the receiver, which drives the switch disc in one or the other direction of rotation. 2. The employment of a switch disc or cylinder having two or more divided rubbing rings, for the purpose of diminishing the number of conductors between the transmitter and receiver, in combination with the rubbing contacts, the latter being placed periodically in connection with the contacts at the transmitter by means of the conductors.

6,631. "Improvements in or relating to electrical apparatus for curative purposes." C. F. AIRD. Dated April 30th. 8d. The apparatus preferably consists of a case containing a suitable battery, preferably a dry one, coil and a contact breaker, and provided with suitable terminals to which the necessary wires may be attached. Where the current is to be applied through the instrumentality of a brush, such as a hair brush, the inventor employs such kind of bristles or equivalent as will convey the necessary current, and he finds that metallic bristles set in an india-rubber or equivalent flexible backing, and in electrical connection with a suitable plate or wires in or upon the brush back or body, give satisfactory results. 4 claims.

7,456. "Apparatus for applying electricity to produce water pressure for fire extinction and like purposes and to operating signals." A. DE BROUCHERE and L. ANSPACH. Dated May 13th. 8d. Claims:—1. In combination with the electrical supply and the water service of a building, dynamo-electric machines and rotary pumps driven by them, with connections of the dynamo machines to the electric supply, and of the pumps to the water service, so that water pressure can be produced when required for fire extinction or like purposes, substantially as described. 2. The commutating switch, whereby the electric current can be directed to lamps or other apparatus ordinarily in use, or through greater or less resistances to dynamo machines working pumps, and to alarm signals.

7,511. "An improved brush for dynamos and motors." M. IMMISCH. Dated May 14th. 8d. Claims:—1. The improved brush for dynamos and motors, consisting of a block of carbon preferably coated with copper except on its contact surface with the commutator, and provided with a plate of copper at its rear end, such plate having an ear or lug to receive the end of the conductor to lead the current from or to such commutator, substantially as specified. 2. The improved carbon brush consisting in a block of carbon coated with copper and having the conductor to lead the current to or from the commutator secured to the rear of such block of carbon, such brush being forced towards the commutator by a spring acting upon a disc or block of insulating material placed on the rear end of such carbon block, so that the latter is insulated from the spring, substantially as specified. 3. The improved carbon brushes with their holders and frame for the commutators of dynamos and motors, constructed and operating substantially as specified.

CORRESPONDENCE.

Tesla's Experiments.

I have been much interested in the accounts given by Mr. Nikola Tesla of his experiments with lamps in which illuminations are obtained without the use of the so-called filamentary conductors.

The subject of the patent referred to by you in page 69, July 17th, 1891, is very similar to that of an old patent granted to me in 1882. During the years 1880 to 1882 I went over almost every experiment detailed by Mr. Nikola Tesla in describing his *new* system of electric lighting.

Many forms of lamps are illustrated and described in my patent, No. 4,752, 1882, entitled "Intensifying fluorescent and phosphorescent electric lighting, whereby the same is rendered serviceable for illuminating purposes, and apparatus for effecting the said intensification." These lamps can be worked at high tension and high frequency, but one of my objects at that time was to work these new lamps at safe pressures, and to some extent I accomplished that by placing both conductors inside the bulb, but still the pressure required is very high.

There is every likelihood of this method of lighting being developed into something useful. The luminous effects, and the heating effects of alternating discharges of electricity are not very well understood; text-books of science and teachers usually treat them as pretty tricks only to be stared at, very much in the same way as they treated the induction coil as a funny scientific toy for giving shocks, before it was discovered to be a transformer.

Illumination is so intimately connected with electrical discharges that we cannot but think that a useful method of electric lighting may be worked out on these lines.

My experiments proved the fact that brilliant lights could be so obtained by using high pressures and moderate frequency, and I believe the only direction in which to work for the production of light without any accompanying heat lies in the direction of high pressure alternating electrical discharges.

I have still by me some of my experimental apparatus and all my notes on the subject, so that I shall shortly communicate an article on the whole subject to this journal, so that our editors may print it if it is found of interest.

Rankin Kennedy.

July 17th, 1891.